THE

TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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THE TELEGRAPHIC JOURNAL.

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1877.

THE past year will probably come to be regarded in telegraphic annals as the year of the articulating telephone. Although the primitive form of this instrument was exhibited at the Centennial Exhibition at Philadelphia in 1875, it was not until 1877, that it was perfected to its present simple shape, and introduced to the world as a practical telegraphic apppliance. Inspired by the enthusiastic verdict of the Centennial Exhibition Commissioners, who characterised his invention as "perhaps the greatest marvel hitherto achieved by the electric telegraph." Professor Graham Bell prosecuted his experiments, and on the 4th of May, 1877, exhibited the speaking telephone in its present pattern to a public assembly in the Boston Music-Hall, U.S. On this occasion, speaking and singing was transmitted with great ease between the hall and the town of Providence, 43 miles distant. During the rest of the year, a great variety of experiments were made to test the powers of the instrument. It was found possible to speak with facility through a resistance amounting to, at least, 12,000 ohms. The longest actual telegraph line as yet spoken through is that from Boston to New York, a distance of 250 miles. The first practical application of the telephone was made in May last year, by the Water Board of Cambridge, Massachusetts, who established telephonic communition with the waterworks under their control. It is stated that more than 500 houses in New England now employ the instrument, and that upwards of 3,000 are in operation in the United States. In this country, where considerable attention has been drawn to it by the visits and lectures of the inventor, there is at present a large demand for telephones, a demand which in all probability would be greatly multiplied were it not for the heavy royalty charged under the patent. In Germany, where there is no patent taken out, the sale of telephones is said to be extraordinary, and the German Government telegraph authorities have promptly adopted them into their system of working, as, indeed, the English postal authorities have also recently done.

The instrument from its nature must become useful in a thousand ways, and is not likely ever to become obselete. Mr. Bell's is as yet the paragon form, and from its extreme simplicity, appears likely to remain so. The feebleness of the sounds which it gives out is, however, its weak point; but it is hoped that this will be remedied in future. Already we hear that M. Trouvé of Paris, obtains more powerful undulatory currents by multiplying the diaphragms of the telephone, so that the vibrations of the voice are taken up by a number of similar vibrating surfaces instead of a single one, and produce a multiplied effect.

The articulating telephone of Mr. Thomas Alva Edison, the distinguished American electrician, followed hard on the back of Professor Bell's, and is said to yield louder sounds, although the articulation is not so perfect, and the apparatus is much more complicated. Its action is based on the discovery of Mr. Edison's, that plumbago has the property of diminishing in resistance under pressure in a degree proportionate to the pressure. This newly discovered property of plumbago promises to become a useful one in telegraphy. Mr. Edison has constructed a novel relay on the principle.

The invention of an apparatus by which it will be possible to graphically record speech at a distance, is a problem which naturally presents itself after the invention of an articulating telephone, and we were only recently informed, from America, that the problem has had a measure of promising success by the daring ingenuity of Mr. Edison. The phonograph, as the instrument for marking down the vibrations of speech is called, is an automatic reporter, such as was predicted by Sir Charles Wheatstone very early in his career, and not strictly a telegraphic instrument; but if used in conjunction with the articulating telephone it will become so, since it will then be possible to record speech at a distance by permanent marks. The most striking result of this invention, should it be perfected to the degree anticipated by the inventor, will be the power which it puts into our hands of storing up the past utterances of people and reproducing them by mechanical mimicry.

During the past year, in addition to the telephone, another practical contribution has been made to us from America, in the shape of Messrs. Prescott and Edison's Quadruplex System of working. The introduction of this system on the London to Liverpool circuit of the postal telegraphs, has been an unquestionable success.

The duplex system of working, by means of Muirhead's artificial lines, has been applied to two very long cables. In the spring, the duplex balance was set up on the Aden to Bombay Cable of the Eastern Telegraph Company, and at the end of the year, the balance was obtained on the direct United States Cable from Ballinskellig's Bay to Torbay. These successes, of native origin, in the difficult province of submarine duplex work, have not been brought about without considerable ingenuity and skill. There has been no marked extension of sub

marine cables during the year, although some sporadic work has been done in duplicating existing sections of cable, and in repairing faults. The loss of the s. s. *Hibernia*, belonging to the Telegraph Construction and Maintenance Company, with a ship-load of cable in Maranham Bay in November, is a casualty still fresh in the memory, and the latest in the train of serious accidents which has attended the laying of the South American east coast cables, a train which includes the loss of the *Gomos* and the *La Plata*.

The adoption of underground in preference to overhead wires by the German Government, is an important indication of the slow revolution which is on foot in favour of the former. It has been settled by law, that in future, all the telegraph lines in the German Empire shall be underground lines. Three main lines have been laid between Berlin and Strasbourg on the one hand, and Berlin and Kiel on the other, while Potsdam has been connected to Cologne. The advantages which subterranean lines have over aërial ones are, a greater immunity from earth currents due to thunderstorms, freedom from sudden changes in insulation resistance, due to changes of the weather, entire removal from such mishaps as the overthrow and breakdown of wires and posts by gales, storms of sleet and snow in winter, or from the violence of mobs. The emancipation of the landscape from its unsightly fetters of rusty wires is by no means a point to be overlooked. The high preliminary cost of the system which has been raised as an objection to its use, will be more than counterbalanced, where the line is properly laid, by the comparatively trifling expenses of maintenance as compared with that for an overhead wire.

The Brown and Allan relay, announced at the beginning of the year, does not appear to have fulfilled the expectations which were formed of its success on long cables, and the Siphon Recorder still retains its impregnable position. We have already mentioned the Edison Pressure Relay; the Theiler Relay for fast speed working, also claims notice for its delicacy and novelty.

The Clamond Thermo-pile, which failed in 1876 to sustain the test of long continued action, and was temporarily rejected, has, we understand, been taken up and improved by Mr. Latimer Clark, C.E., and promises to be more trustworthy and serviceable than it has been heretofore.

The electric light has been conspicuously before us during the past year, and has made some decided advances both in the way of improvement and in its practical application. This activity has been almost exclusively confined to the Continent, where a great number of experimental trials have been made, and works, warehouses, promenades, railway stations, ships, and locomotives lighted by its means. In England it has been applied to Transatlantic steamers, and to ironclads as a means of defence against the attacks of torpedo-boats made under cover of darkness. In June last, the new "electric candle," with the kaolin wick, of the Russian engineer, M. Jablochkoff, was publicly exhibited at the West India Docks, and was considered to be a striking success. In France, the magneto-electric machine of Lontin, by which a number of separate currents of different strengths are generated and distributed to separate circuits in order to feed a separate light in each, has been successfully tried and tested in a long series of experiments made at the Lyons railway-station in Paris, and we believe it has been finally adopted there.

In connection with lighthouse illumination by electricity, the most notable event of the year is the comparative trial of the magneto-electric machines of Siemens, Gramme, and Holmes, made at the South Foreland lighthouse for the Trinity House Board. These trials established the decided superiority of the Siemens' machine over those of Gramme and Holmes which were experimented upon.

In Electrical Science, if no important discovery has been made, the usual amount of minor work has been going on. Dr. Burdon Saunderson and Professor Dewar have carried on investigations on the electromotive power of the tissues of plants and animals. Dr. Saunderson has shown that in plants the leaves and in animals the nerves and muscles are electromotive, while Professor Dewar has shown that light falling on the eye gives rise to an electric current in it. The deposition of metals in films upon glass or other foreign substance by the discharge from an induction coil is also worthy of mention, and is due to Dr. Wright, an American. Count Du Moncel has been as industrious as ever.

In electrical literature the principal works of the year have been Mr. Prescott's "Electricity and the Electric Telegraph;" Mr. Langdon's treatise on the "Application of Electricity to Railway Working;" and M. Hippolite Fontaine's book on "Lighting by Electricity."

The year 1877 is memorable for the deaths of Colonel Robinson, Chief of the Indian Telegraphs, of Alexander Bain, and of Dr. Smee. Bain was distinguished as the inventor of the electro-chemical telegraph, the automatic system, and the electric clock. Smee was well known in telegraphy as the inventor of the Smee battery. The latter was a skilful physician and an accomplished gentleman, the former was an uneducated clockmaker, who, by his extraordinary native genius, seldom, if ever,

paralleled in the history of invention, covered himself with a wealth and distinction, which, by temperament and training, he was unfitted to support. Like many other inventors, Bain succumbed to his own success, and died in a state of poverty; but he has left behind him an imperishable name.

The condition of business amongst telegraph contractors during the year cannot be called other than dull. Contractors who do not supply the home government with materials, depend for orders on foreign governments, and it is well known that there is very little activity amongst these at present, owing to the reserved condition of the money market. Contractors are even reduced to tendering for orders at rates under cost price, so as to be able to keep their machines in operation and avoid deterioration of their plant. In default of large foreign orders, attention has been turned to furnishing domestic articles, such as electric bells, telephones, and magneto-electric engines for sewing machines. There is, moreover, little sign of improvement during the ensuing year. There are rumours of schemes in the air, but nothing more. Telegraphic industry is passing through a period of eclipse just now, and must perforce wait in patience, consoling itself with the reflection that like every other eclipse it will in time pass by.

FULLER'S PATENT INSULATOR.

The form given to insulators for open telegraph lines has almost invariably been that of an umbrella

Fig. 1.

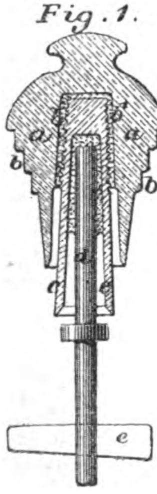


Fig. 2.

or bell with curved or parallel sides. Most of these particular forms are no doubt due to careful thought, and have been decided upon after numerous experiments. Many of them, however, are such as would lead one to doubt whether any consideration had been given to the obvious rules which must be followed if both mechanical strength and high insulation in all weathers, are to be obtained.

The insulator, recently introduced by Mr. Fuller, seems to possess these two necessary qualifications in a high degree. Its form is that of an inverted truncated cone, by which not only great mechanical strength is provided at that portion of the insulator which has hitherto been found to be weak, and which frequently bursts from the expansion of the iron bolt to which the porcelain is fixed, but with the converging sides of the cone, the insulation is vastly improved by the surface over which the leakage can take place being comparatively small.

The peculiar shape of the improved insulator renders it less liable to the retention of any dust or moisture on its surface than is the case with insulators of the usual forms, while the danger from either external or internal fracture is reduced to a minimum.

The resistance offered to the escape of the electric current over the surface of the porcelain, is still further increased by corrugating, serrating, or undercutting the outside surface of the cone. By this means the downward flow of any moisture which may collect on the surface of the porcelain is broken at several points, and consequently a continuous conducting film can only be formed with great difficulty, if at all.

Another feature in the improved insulator is the method by which the two parts of the insulator, an inner and an outer cup, are fixed together. Instead of employing cement for this purpose, which would rigidly connect the two parts, Mr. Fuller uses a tightly fitting india rubber ring. By the employment of the latter it is possible to separate the two parts for examination, cleaning or renewal, without unbinding the line wire. This is a very great point, and is, we believe, a feature possessed by no other form of insulator. The elastic connection between the two parts must render their liability to break from unequal expansion or from any sudden jar to the wire, very small; also the high insulating property of the rubber must be very beneficial.

In the iron supports or bolts in common use, it is found that the nut and screw required for fastening the insulator to the bracket becomes fixed together so firmly by rust, that great difficulty is experienced in removing the nut when it is necessary to shift the insulator. Mr. Fuller gets over this difficulty by the simple expedient of using a bolt having a slot at the lower end through which a wedge is driven.

Fig. 1 is a vertical section, and fig. 2 a side elevation of the insulator. *a* is the inverted truncated cone portion, and *b b* are the corrugations, serrations, or under-cuttings thereon.

The separate inner cup is also shown in fig. 1, where *c* represents the inner cup and *b'* the vulcanised india rubber ring, *d* is the metal support insulated, as shown, from the inner cup *c*.

If preferred, the inner cup *c* may, of course, be cemented to the inverted cone *a*, though the advantage of the elastic connection would be lost thereby.

e e, figs. 1 and 2, show the wedge or cutter passing through a slot in the metal support *d*.

A SKETCH OF THE DEVELOPMENT OF THE ELECTRIC LIGHT.

By J. MUNRO, C.E.

(*Continued from page* 309.)

The next important advance was made in 1866, when Mr. H. Wilde, of Manchester, announced the somewhat paradoxical principle that a current or a magnet indefinitely weak could be made to induce a current or a magnet of indefinitely great strength. Wilde showed, in fact, that by means of a slight trace of magnetism a feeble current could be generated in the armature, and that that current could be used to excite an electro-magnet, which would in turn re-act on the armature, so as to generate a more powerful current in the latter. By employing this current to excite the electro-magnet still more, a still stronger current could be induced in the armature, and so on until the current in the armature was of the required strength. The weak initial magnetism required could be obtained from a permanent magnetism, or the residual magnetism of the core of the electro-magnet, caused by the temporary flow of a voltaic current through the coils of the electro-magnet. On this principle, Wilde constructed a very powerful machine, which, under improved forms, is now in use. He provided two armatures—one for intensity, and one for quantity—and wound them longitudinally, after the manner of Siemens. The quantity armature was wound with folds of insulated copper-plate or ribands instead of wire. With an armature of this kind, ten inches in diameter, Mr. Wilde melted an iron rod fifteen inches long and a quarter of an inch thick. With an intensity armature of the same diameter, he produced a light from half-inch carbon electrodes, which, at a distance of a quarter of a mile, cast shadows from the flames of the ordinary street lamps against the neighbouring walls. The same light at two feet distant from the reflector darkened ordinary sensitised photograph paper to as deep a hue in twenty seconds as the direct rays of the sun at noon of a clear March day did in a minute.

Various useful dynamo-electric machines, as they have been called, were planned on Wilde's principle by electricians both at home and abroad. S. A. Varley, Siemens, and Wheatstone showed that the residual magnetism of the core of the electro-magnetism was sufficient to originate a current which, by the above process, could be made to generate powerful currents in the armature; and that this current could be utilised for the electric light by *shunting* off a part of it through a circuit derived from the electro-magnet circuit, and in which the electrodes of the light were placed. The strength of the current, which can be generated by this reciprocal magneto-electric action, is limited by the magnetic capacity of the core of the electro-magnet, and also in some measure by the heat generated in the rotation of the armature. In 1867, Mr. Ladd, London, exhibited at the Paris Exhibition a machine with two armatures, of which one was employed to *feed* the exciting electro-magnet with current, and the other to produce the useful or light-giving current. Mr. Tisley improved Ladd's machine by adding a novel commutator, and also cooling the bearings of the armature by passing a stream of cold water over them.

The next great advance was made by Zenobe Theophile Gramme, of Paris, who patented his machine in England in 1870. Gramme's machine involved the new principle of forming the moveable armature of an endless ring of soft iron, round which are coiled a series of separate helices or bobbins connected in circuit one after the other. Each of these coils *ride*, as it were, on the soft iron ring, and is carried round with it across the lines of force between the poles of the magnet, which may be either a powerful permanent magnet built up of thin laminæ, or electro-magnets excited by the armature itself in the way we have been considering. The induced magnetic poles in the ring are continuously shifting round the ring as it revolves, and the effect on the bobbins is the same as if two opposite poles, diametrically apart, revolved continuously round them. In one revolution, while the bobbins on one half of the ring are passing a north magnetic pole, those on the other half are passing a south pole. One half of the bobbins will therefore yield induced currents in one direction, while the other half yield them in the other direction. Each bobbin is like the element of a Leyden battery, and yields its momentary current; but the rapid succession of the series of bobbins produces a practically uniform current. The ends of each bobbin are swept by a pair of metal brushes, which collect the magneto-electric currents generated in them. Each brush collects the opposite currents in order to convey it away for use, and thus the brushes resemble the poles of a voltaic battery. Gramme's machine possesses extraordinary power.

In Siemens improved machine, patented 1873, Gramme's plan of having a number of separate coils in series on the armature, with metal brush-contacts for leading off the currents, is applied to Siemens' armature, that is to say, instead of having a single coil wound longitudinally on the armature and a commutator to divert the alternating currents, a number of longitudinal coils are now connected up in series and rubbing contacts substituted for the

commutator. Siemens, however, further improves his machine by detaching the soft iron core from the armature and keeping it fixed, the coils of the armature alone being moveable. These coils are wound on a light shell which revolves rapidly in the highly magnetic space between the poles of the magnets and the fixed core of the armature. The distinction here between Siemens' and Gramme's machines lies in the fact that whereas Gramme rotates his soft iron armature core along with its coils, Siemen keeps it fixed and rotates the coils round it.

At least two other new forms of magneto-electric machines are worthy of mention. Wilde's form, patented in 1873, and Lontin's, patented in 1876. The novel feature of Wilde's machine consists in causing the rotation of an iron armature to generate the induction currents, not in coils round the armature itself, but round the prolonged ends of the magnets which produce the magnetic field. M. Francois Lontin's plan is simply another means to the same end; the inducing electro-magnets are prolonged and encircled by extra coils in which the rotation of the armature generate currents which can be employed for the electric light. An obvious advantage of this plan of Wilde and Lontin, is that a number of distinct currents can be generated by the motion of the armature, each in its own particular electro-magnet, which can be utilised for different lights.

There are several other very useful magneto-electric machines, such as the Alliance or Nollet machine, Noble's, Ladd's, Breguet's, Holmes', &c., but they do not involve original improvements of sufficient importance to deserve an extended description here. Gramme's machines have been described in greater detail already in the *Telegraphic Journal*, vol. 3, p. 184. vol. 5, p. 190; and Siemens' also in the *Telegraphic Journal*, vol. 1, p. 320, and vol. 5, p. 272. The recent comparisons of these two machines at South Foreland by the Trinity House, show results in favour of Siemens'. This instructive report is to be found in the *Telegraphic Journal* for Nov. 1, 1877.

While invention was, step-by-step, perfecting the magneto-electric machine, regard was also had to the bettering of the carbon points or luminous electrodes of the light. The wasting of the carbon points necessitated a contrivance for regulating the distance between the points, so as to keep the arc of sensibly constant width. The electric arc has a considerable resistance in ohms, and its resistance increases or diminishes according as the width is greater or less. With the rise or fall of resistance in the arc, the current diminishes or increases. It occurred, therefore, to Foucault, the first inventor of the regulator for the carbon points, to cause the current by means of an electro-magnet to move the points to or from one another, according as the arc became too wide or too narrow. When the points are at their proper distance, the current, by means of the electro-magnet through which it passes, is made to hold a detent which keeps the points steady. But when the arc widens, and the current gets weaker, the detent is released, and the points are permitted to approach. Foucault's regulator was improved by Serrin and by Dubosq. Serrin's form had two independent trains of clockwork, one designed to allow the points to approach, the other to draw them apart. These trains were actuated by the current passing through an electro-magnet. Dubosq's form is the best known, and is merely an improvement on Serrin's. The current passes through an electro-magnet and thereby opposes a coiled spring. The spring tends to bring the points closer, the electro-magnet tends to push them apart. Their actual position, therefore, depends on the strength of the current. If it is weak, the spring overpowers the magnet and brings the points nearer. If it is strong, the magnet overpowers the spring and pulls the points wider apart. M. Lontin effects the same purpose by the dilatation of a fine silver wire which actuates a system of levers.

The nature of the points was also a matter for research and invention. The value of carbon as electrodes is the whiteness and abundance of the light it yields, and the fact that it does not fuse at the high temperature of the arc. But there is a want of uniformity in the structure of carbon; it is porous, absorbent, and is given to spark and explode in burning. These qualities, together with its rapid disintegration and combustion, are objections to its fitness for electrodes. Other substances, such as spongy platinum, iridium, palladium, were suggested and tried. A very fine green light was obtained from a stream of mercury falling upon a platinum or carbon plate. The mercury was one electrode, the plate the other, and the light appeared where the mercury broke in globules on the plate. Professor Wray proposed to employ this plan for lighthouse illumination. Carbon steeped in various chemicals was tried. When it is soaked in nitrate of strontium or chloride of zinc the arc is very equable and constant, but the light is coloured. The colouring of the light due to these different metals was also against their adoption. Loose carbon between metal electrodes in a sealed glass tube yielded a good light, and had the advantage of requiring no regulator. It is an idea as old as 1841, and almost anticipates one of the most successful of recent lights. In 1856, Mr. Harrison proposed to set the points at right angles to each other, and to give the positive point a motion of rotation round its own axis, and the other a motion of translation, so as to secure that the fresh carbon surface should come under the negative point. This useful idea was revived by Mr. Whitehouse a few years ago. The quality of the carbon itself was greatly improved. With wood charcoal the light is more vivid and whiter than with coke. There are several French makers of carbon points. M. Archereau prepares them of finely-divided carbon and magnesia, pressed; M. Carré, of fine coke-dust, lamp-black, liquid gum, and sugar, baked; M. Gaudoin, of tar, resin, or mineral oil carbon, pressed, and wood charcoal. Those of M. Gaudoin are said to be the best. Enclosing the carbon in glass prevents the air from deranging the arc.

With the perfecting of magneto-electric machines and the refinement of the points, the carbon light became successful as an illuminator where powerful lights were required, as for flashing signals, theatrical effects, and beacons on land and at sea. In 1862, England took the lead in applying it to lighthouse purposes at Dungeness. The following year France established the light on Cape La Heve, and, among others, the Cape Grinez light was set up in 1869, and the South Foreland in 1872; these two latter

making, with Dungeness, a triangle of lights over the Channel.

These powerful and somewhat expensive lights, however, are unfit for the general illumination of streets and buildings. With such small individual lights as are there required, the carbon points are unreliable and the lights unequable. The necessity of regularly supplying fresh points is also an objection; but the main difficulty lies in the proper division of the light among various jets of different sizes. It is clear that by connecting a number of different sets of points in series, the break-down of one set would interrupt the current and extinguish the whole. Again, the use of a variety of circuits derived from each other, and dividing up the main current from the machine into a number of branch currents, is attended with several practical difficulties; for example, the extinguishing of one light would increase the brightness of the rest, since the current which had been supplying it would help to strengthen the currents in the other branches.

(*To be continued.*)

EDISON'S TALKING PHONOGRAPH.

THE principle on which the machine operates is as follows:—There is, first, a mouth piece, A, Fig. 1, across the inner orifice of which is a metal diaphragm, and to the centre of this diaphragm is attached a point, also of metal. B is a brass cylinder supported on a shaft, which is screw-threaded and turns in a nut for a bearing, so that when the cylinder is caused to revolve by the crank, C, it also has a horizontal travel in front of the mouthpiece, A. It will be clear that the point on the metal diaphragm must, therefore, describe a spiral trace over the surface of the cylinder. On the latter is cut a spiral groove of like pitch to that on the shaft, and around the cylinder is attached a strip of tinfoil. When sounds are uttered in the mouthpiece, A, the diaphragm is caused to vibrate and the point thereon is caused to make contacts with the tinfoil at the portion where the latter crosses the spiral groove. Hence, the foil, not being there backed by the solid metal of the cylinder, becomes indented, and these indentations are necessarily an exact record of the sounds which produced them.

It might be said that at this point the machine has already become a complete phonograph or sound writer, but it yet remains to translate the remarks made. It should be remembered that the Marey and Rosapelly, the Scott, or the Barlow apparatus proceed no further than this. Each has its own system of caligraphy, and after it has inscribed its peculiar sinuous lines it is still necessary to decipher them. Perhaps the best device of this kind ever contrived was the preparation of the human ear made by Dr. Clarence J. Blake, of Boston, for Professor Bell, the inventor of the telephone. This was simply the ear from an actual subject, suitably mounted and having attached to its drum a straw, which made traces on a blackened rotating cylinder. The difference in the traces of the sounds uttered in the ear was very clearly shown. Now there is no doubt that by practice, and the aid of a magnifier, it would be possible to read phonetically Mr. Edison's record of dots and dashes, but he saves us that trouble by literally making it read itself. The distinction is the same as if, instead of perusing a book ourselves,

FIG. 1.

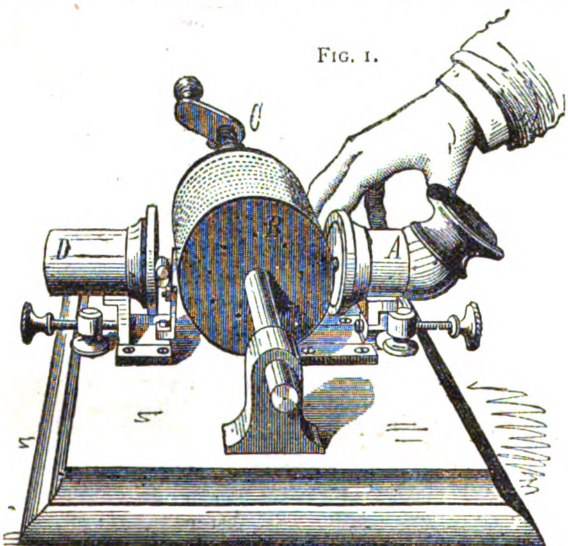
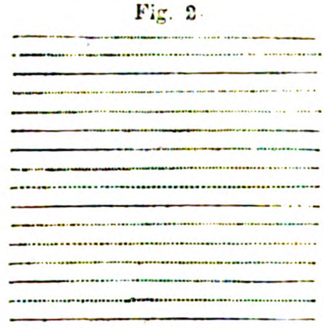


Fig. 2



we drop it into a machine, set the latter in motion, and behold! the voice of the author is heard repeating his own composition.

The reading mechanism is nothing but another diaphragm held in the tube, D, on the opposite side of the machine, and a point of metal which is held against the tin-foil on the cylinder by a delicate spring. It makes no difference as to the vibrations produced, whether a nail moves over a file or a file moves over a nail; and in the present instance it is the file or indented foil strip which moves, and the metal point is caused to vibrate as it is affected by the passage of the indentations. The vibrations,

however, of this point must be precisely the same as those of the other point which made the indentations; and these vibrations, transmitted to a second membrane, must cause the latter to vibrate similar to the first membrane, and the result is a synthesis of the sounds which, in the beginning, we saw, as it were, analysed.

In order to exhibit to the reader the writing of the machine which is thus automatically read, we have had a cast of a portion of the indented foil made, and from this the dots and lines in Fig. 2 are printed in of course absolute facsimile, excepting that they are level instead of being raised above or sunk beneath the surface. This is a part of the sentences, "How do you do?" and "How do you like the phonograph?" It is a little curious that the machine pronounces its own name with especial clearness. The crank handle shown in our perspective illustration of the device does not rightly belong to it, and was attached by Mr. Edison in order to facilitate its exhibition to us.

In order that the machine may be able exactly to reproduce given sounds, it is necessary—first, that these sounds should be analysed into vibrations, and these registered accurately in the manner described; and second, that their reproduction should be accomplished in the same period of time in which they were made; for, evidently, this element of time is an important factor in the quality and nature of the tones. A sound which is composed of a certain number of vibrations per second is an octave above a sound which registers only half that number of vibrations in the same period. Consequently, if the cylinder be rotated at a given speed while registering certain tones, it is necessary that it should be turned at precisely that same speed while reproducing them, else the tones will be expressed in entirely different notes of the scale, higher or lower than the normal note, as the cylinder is turned faster or slower. To attain this result there must be a way of driving the cylinder, while delivering the sound or speaking, at exactly the same rate as it ran while the sounds were being recorded, and this is perhaps best done by well-regulated clockwork. It should be understood that the machine illustrated is but an experimental form, and combines in itself two separate devices—the phonograph or recording apparatus which produces the indented slip, and the receiving or talking contrivance which reads it. Thus in use the first machine would produce a slip, and this would for example be sent by mail elsewhere, together in all cases with information of the velocity of rotation of the cylinder. The recipient would then set the cylinder of his reading apparatus to rotate at precisely the same speed, and in this way he would hear the tones as they were uttered. Differences in velocity of rotation within moderate limits would by no means render the machine's talking indistinguishable, but it would have the curious effect of possibly converting the high voice of a child into the deep bass of a man, or *vice versâ*.—*Scientific American.*

ERRATUM.—Review of "The Application of Electricity to Railway Working," page 311, 2nd column, line 27, *for* "does not really give any," *read* "really gives that."

THE TELEPHONE AND ITS APPLICATION TO MILITARY* AND NAVAL PURPOSES.

By W. H. PREECE, Vice-President Soc. T. E. and Member Institution Civil Engineers.

No one can deny the enormous value of the electric telegraph for warlike purposes. It has well nigh revolutionised the art of war. It has become a great weapon of offence, as well as a great shield of defence. Operations that were a few years ago impossible are now regarded as essential. The strategist in his office can now grasp a continent in his combinations. The actual manœuvres of armies can be controlled and directed like the toy figures of the game of Kriegs-spiel. The maintenance of the lines of telegraph to an army in the field is as important as that of the more material lines of communication. The telegraph, in fact, has become a necessity of the age. No war could now be undertaken without its aid.

But it is not only in annihilating space, and bringing within the mental view of the master mind a dozen armies and a million men, that telegraphy is so valuable; it is in the rapid communication of intelligence and orders to and from the commanding officers of each limb of each army, however small; it is in connecting together, in immediate communication, the different parts of a fortress or an entrenched camp, however much they may be scattered; it is in maintaining an uninterrupted connection between all parts of a besieging force, however extensive may be the lines of circumvallation, that it is so serviceable. It would have been impossible to have kept on the sieges of Paris and Metz without it. Indeed, it has a civilising influence, for it not only tends to shorten the duration of war, but to diminish the loss of life, by rendering possible those combinations which, in the cases of Sedan as well as of Metz, swallowed up temporarily in prison two great armies. Moreover, it facilitates the supply of food, it regulates the traffic on railways, and it aids the transport home of the sick and wounded; it satisfies the craving for news, and it alleviates anxiety. It is well known that the Germans, guided by their experience of 1866, commenced the war of 1870 with a very well organised and extensive system of telegraphs for field service, but that the French had a system wanting in efficient organisation and miserably deficient in men and material. We know little of the present Russian system, excepting the fact that by its aid the army around Plevna maintained its bear-like hug on the doomed fortress, and enabled it to thwart, with overpowering force, the tiger-like rush of Osman Pasha.

So important is efficient telegraphy now considered for the British Army, that 6 officers and 160 men are being trained and maintained in efficiency in the British postal telegraph system, so as to be available in time of war. They are, in fact, daily rehearsing that part which they may have some day to perform in earnest in an enemy's country. Moreover, we have our field telegraphs in constant training at Aldershot, Chatham, and elsewhere, though it is very doubtful whether this

* Read before the Royal United Service Institution, Dec. 21st.

department has been nearly sufficiently developed, or is anything like being properly equipped, for such an army as ours. However, I am here, not to criticise or describe the equipment of our military telegraphic system, but to describe an apparatus which may prove a most useful and valuable adjunct to the already well-matured system of waggons and barrows and cables in actual use. I must draw a distinction between the permanent telegraphic system of the country occupied by an army, the semi-permanent lines of telegraphy which connect headquarters, as it advances, with this system, and the "flying line," or temporary system of field telegraphs which follows the movements of the various corps in the field, and maintains their communication with headquarters. The first two must necessarily be worked on the ordinary telegraphic system in use, maintained by technical skilled labour, and worked by well-trained, experienced telegraphists. The flying line need not necessarily be so manipulated. There is also the visual system, intended for outpost and reconnoitring duties, and which necessarily must be continued under circumstances which render field telegraphs impractical. I do not intend to refer to this admirable system.

At present, the apparatus in use for field telegraphy is the ordinary Morse recording apparatus, which records its messages in the ordinary dot and dash alphabet, understood only by the initiated, supplemented by a sounding instrument, which appeals, by a similar foreign language, to the ear. Thus, to convey intelligence from one point to another, a message has to be written down on paper. It has then to be translated by a telegrapher into the Morse language, which has to be re-translated at the distant end into the ordinary written language, and then read by the recipient. These operations are subject to error, and have not secured faith in their reliability. Is there any commanding officer here present who would not wish such an uncertain agent in a very warm place? Those who were present at the Autumn Manœuvres on Salisbury Plain know how to value its services. It is unquestionable that the telegraph has not inspired confidence, and this is due as much to its natural uncertainty as to the want of knowledge of the tool that is used. Accuracy in the transmission of orders is the *sine quâ non* of a military telegraph. We know of one great disaster that arose from a mistake. "Some one has blundered." It was the very last thing determined upon in our late Ashantee War, and the rapidly collected materials drawn from the Post Office stores were dispatched at the last moment by passenger train, and stowed in the officers' baggage room. Yet we have the authority of Sir Linton Simmons for saying that the operations in that war could not have been carried on as they were without its assistance, and that it was productive of very great economy to this country by shortening the expedition, and enabling the greatest amount of benefit to be derived from the materials and means that were placed at the disposal of the general in command.

Now, the telephone, if it prove a practical instrument, will place in the hand of every officer an instrument which will transfer the actual words and tones of his own voice to his correspondent at any reasonable distance. I have spoken distinctly at various distances up to ninety miles, and I have been able to recognise, with absolute certainty, the voices of different people at sixty-seven miles. It will solve the moot question as to the best form of instrument for military telegraphs, about which there is much diversity of opinion.

How is it that the human voice itself can be reproduced at such distances? When I strike a bell, blow a whistle, sound a reed, clap my hands, or speak to you, how is it that these different operations are conveyed through your ears so as to produce on the brain that sensation which is called *sound?* The air itself, in which we breathe and move and have our being, is a highly elastic medium, which readily receives and transmits any motion imparted to it. When I clap my hands I suddenly throw this air into motion; a wave is formed, just like a stone thrown into water generates a wave that circles round and round, striking and enveloping everything in its course. This air-wave likewise envelops everything in its course, and impinging upon the tympana of your ears, it there affects the nerves in such a way as to convey to the brain that sensation which education has taught us to be that sound due to the clapping of hands. Sound is therefore simply the undulations of the air; but there is sound and sound. I shake this box of nails; it makes a hideous row. I blow this reed; it makes a soft musical tone. Why have we in the one case *noise* and in the other *music?* In the one case the waves follow each other in irregular, spasmodic fashion, shivering the drum of the ear with unpleasant shocks; in the other case the waves follow each other regularly, periodically, and rythmically, blending together on the drum of the ear with pleasant sensations. Let us ignore noise, and confine ourselves to this musical instrument. I blow a note. If it were possible to illuminate a tube of air between the mouth of this instrument and any one of your ears, you would see this air chased and moulded into the most beautiful and regular undulations; not rises and falls, like the vertical waves of the sea, but condensations and rarefactions—close order and open order—more like a field of barley in autumn time responding to the motion of a gentle breeze. If we conceive a line of particles to be arranged along this tube, like a long file of men or a row of marbles, then if each particle takes an excursion to and fro for the same distance (the same *amplitude*), however small, then if the motion of each particle be successive, and not simultaneous, the line will be excited into waves or sonorous vibrations.

Now let us fix our attention upon this musical instrument and this suppositious tube of air. I can produce various *notes*. One note differs from another note only in the number of waves or sonorous vibrations produced per second. Middle C of the piano makes 264 of these vibrations, E 330, F 352, A 440, and the octave to C 528 per second. The lowest note that can be heard by the human ear is 16 complete vibrations per second; the highest, 38,000. The range of the human voice is between 65 and 1044 sonorous vibrations per second. Whenever and however we produce air vibrations pursuing each other regularly between these two limits, we have *notes*. And one note differs from another note in its *pitch*, which is the number of its sonorous vibrations per second. But these notes may be soft and gentle, or rough and loud. Hence notes differ,

not only in their *pitch*, but they differ in their *loudness*. Loudness depends upon the energy of the source of sound, and upon the amplitude of the consequent vibrations of the particles of air. If I blow gently, the excursion to and fro is small. If I blow fiercely, the excursion to and fro is great. The former undulations strike the ear gently, and the sensation is low; the latter strike it fiercely, and the sensation is loud. Again, I take three or four different instruments, and I sound the same note on each with the same force. The pitch is the same, the loudness is the same, but there is no mistaking their difference. This difference is called their quality, clang-tint, or *timbre*. Now what causes this clang-tint? I must beg your attention here, for here lies the secret of the new articulating telephone. This clang-tint is due to the *form* of the wave of air. It is very difficult to conceive a difference in the form of a wave of air. It is simple enough when we regard water. We see this for ourselves upon the surface of a pond or of the mighty deep. But the difference of an air-wave lies, not in its geometrical form so much as in the rate of motion of its different particles. I wave my hand backwards and forwards regularly or irregularly. I can make it move at any given rate, at any given time, and, though the number of excursions and the amplitude of excursion to and fro per unit of time may be the same, I can vary the form or rate of excursion at will. This produces difference of quality, and this is why middle C, sounded on the piano, on a harp, on a bugle, or by the voice is the same note, but differing so much in clang-tint. It is impossible to picture in the mind the beauty and minuteness of the sound-waves. The ear, though approached by a channel the diameter of only a quill, will receive the vibrations from a hundred voices and instruments, and can separate each by attention. Hence we arrive at our first proposition, that sound is due to the undulations of the air, and that, as these undulations vary in number per second, in amplitude, and in form, so we have noise or music varying in pitch, in loudness, and in clang-tint.

(To be continued.)

THE "TIMES" AND TELEGRAPHY.

ENGLISH electricians will read with satisfaction the following article in *The Times* of Christmas Day :—

"The first article in the December number of the Berlin 'Archiv für Post und Telegraphie' is entitled 'Germany's Share in the Development of the Telegraph.' It urges that the article on 'Telegraphic Progress' which appeared in *The Times* of November 22, is written in too insular a spirit, and that while the claims of certain Englishmen and Americans are set forth, the work of the scientific men of other nations has not been duly recognised. The progress of the telegraph has been an international work even from its earliest stages, and to claim as *The Times* article has claimed that all the discoveries up to 1843 were due to English genius is not a fair representation of facts. It recognises that Le Sage's name is just mentioned, but indicates that his work is too lightly passed over and draws attention to the fact that many important names associated with work on which telegraphic progress is founded are altogether omitted. There are, it says, not a few Germans who have made themselves worthy to be prominently mentioned, as there are also philosophers of other nations. For example, without the discovery of galvanism the present science of telegraphy would have been an impossibility, and with this discovery the names of the Italian philosophers, Galvani and Volta, are closely bound up, while the discovery of the principle of the galvanometer is due to Œrsted, a Dane, almost simultaneously with Schweiger and Poggendorf. The invention of the galvanometer was the first step towards the needle telegraph, and the honour of first seeing the application of this is due to the French *savant* Ampère. The laws of the strength of currents, without which apparatus could not be rationally constructed, were first worked at in 1825 by the distinguished German Ohm, which led to the discoveries in 1845 by Kirchoff. Then came the 'epoch making' labours of the Göttingen Professors Gauss and Weber. These facts the German writer considers are sufficient to show that it is an 'arrogant assumption' on the part of the English writer to claim the earliest stages of the invention and development of the telegraph as purely English. When the British Association appointed a committee to report on suitable units as the standard of electrical resistance there were four names suggested for them—an Ohmad, a Volt, a Weber, and a Faraday—so that here there were recognised one Englishman, one Italian, and two Germans. The article goes on to point out that the constant battery is due to Becquerel and Daniell, and the discovery of the earth circuit and the application to the telegraph is due to Steinheil. The first idea for the employment of galvanic currents for telegraphic signals originated with Sœmmering. He showed how the chymical decomposing property of the currents could be made to indicate letters (as Le Sage had with frictional electricity), and exhibited his 'water decomposition telegraph' at an Academy meeting in 1809. He may be regarded as the real founder of our present telegraphic knowledge, as he was the first to recognise the possibility of employing galvanic electricity to convey signals to a distance. The needle telegraph came as the next step—the deduction from the galvanometer; and here the Prussian Schilling, with his submarine wire, must be named, as well as Gauss and Weber (1833). Fothergill Cook, who is named in *The Times* article in connexion with Wheatstone as inventor of the needle telegraph, was in 1835 at Heidelburg studying wax modelling for the museum of the University of Durham, when he accidentally saw an instrument that belonged to Muncke, with which it was possible to telegraph from one room to another. He took up the idea and worked it out with Wheatstone, but he cannot claim the invention. Siemens, Von Chauvin, Halske, and Edlund are mentioned in connexion with the development of duplex and quadruplex telegraphy, but the writer has omitted to mention the name of Edison, which, perhaps, should take the place of the names of Prescott and Gerritt Smith. The comments of the German writer, prejudiced as they are, usefully draw attention to the fact that a good international history of the telegraph has still to be written."

The "arrogant assumption" there alluded to is confined solely to the writer of the article "On Telegraphic Progress." The art of telegraphy, like science in general, is purely international, and English telegraphists accept and acknowledge unreservedly all contributions from abroad. No standard work can be pointed out which does not fully acknowledge all that the German writer contends for, and it is unfair to saddle upon the profession at large that "insular spirit" which is confined to an ignorant writer in *The Times*.

THE KAFFIR WAR AND THE TELEGRAPH.

WE are very glad to find that owing to the able and astute management of Mr. Sivewright, of the Telegraph Department of Cape Colony, the services rendered by it during the late Galeka affair has been such as to elicit a warm acknowledgment of them by the Commissioner of Crown Lands and Public Works, Mr. John Merriman.

We give the text of Mr. Merriman's letter with much pleasure, as it shows how great is the value of a telegraph system properly managed at such moments as that referred to. We trust that the Cape Government will be as ready to acknowledge these services as is their Commissioner, and we congratulate Mr. Sivewright on the energy displayed by him.

"King William's Town,
"12th Nov., 1877.

"MY DEAR SIR,—I cannot allow you to leave King William's Town without expressing to you the high sense which I entertain of the services rendered by you to the colony during the past trying six weeks. I have no hesitation in saying that to your personal presence in King William's Town has been owing in a great measure the admirable service which the telegraph has been able to perform during the war. Nothing can have exceeded the cheerfulness and skill with which, at a time when frequent interruptions would have been beyond calculation detrimental, you devoted yourself with marked success to the duties of your department with a zeal and tact beyond all praise, and for which I have personally to anticipate the thanks which at a more fitting time the Government will communicate to you.

"I am, my dear Sir,
"Yours truly,
"JOHN X. MERRIMAN,
"Commissioner of Crown Lands and Public Works."

"J. SIVEWRIGHT, Esq.,
Aliwal North."

THE DESTRUCTION OF SUBMARINE CABLES.

SUBMARINE CABLES are subject to numerous causes of deterioration. In the first place, on Northern shores, there are the banks of floating icebergs, which sometimes extend to a depth of 500 or 600 metres. In their journey southwards, these ground and break up under water; the broken masses dislodge the cable which crosses their path. This kind of accident often occurs to the Atlantic Cables on the coasts of Newfoundland.

Next to ice-banks must be mentioned wear and tear on rocky bottoms. Near the coast-line, says M. Ternant, in a treatise on the repairing of submarine cables, the depth may vary rapidly, so that the cable does not lie evenly on its bed; one end lying on a rock may have to bear the entire weight of the portion of cable which is unsupported. A continuous to-and-fro movement, arising from the agitation of the sea or from ordinary tides or currents, determines the gradual wearing away, albeit slow, of the external wires. The sheathing once destroyed, the conducting wires yield and break, or the continued attrition of the core lays bare the conductor, making earth and stopping communication. The cable between Bonifacio and Sardinia was interrupted in 1861 from this cause; and the six conductors it contained were broken by the stretching inside the gutta-percha, which only yielded to the strain in picking up. We may further mention as causes of destruction, coral-beds, earthquakes, submarine eruptions, and high temperature on tropical coasts.

The enemies in the animal kingdom are not less numerous. A curious observation was made after the laying of the cables on the Brazilian coast. As is known, Brazil was connected with Portugal in 1875. At the same time a series of cables round the coast completed the system from Pernambuco to Para, Cayenne, Demerara, and the Antilles. The observation referred to was made in the Para-Cayenne section. It consisted of singular bites due to attacks made by the saw-fish, which abounds in those parts. A similar occurrence to the Singapore Cable in 1871 was described in *La Nature* in 1873 (Vol. I., p. 160). Mr. Buckland found among his collection a fish-jaw, from which he detached the saw; and with this he reproduced upon a piece of cable a fault similar to that which had caused the interruption.

In Brazil, this kind of fault has become chronic; we gather our information from the engineers in charge of the laying. In the first piece which failed, one of the protecting iron wires was wrenched so as to expose the hemp with which the core was served. In the centre of this part a piece of bone, apparently the scale of a fish-tooth, was found thrust through the hemp into the gutta-percha. On the same side of the cable, about two inches distant, another piece of bone was found in a similar position. Each of these scales was about one inch in length, and about one-eighth of an inch in diameter.

In another fault, one of the wires was bent inwards, the remainder of the strand being slightly deformed and the "lay" taken out. One of the crew, during the heaving in, drew out from the cable a triangular splinter of enamelled tooth, about a quarter of an inch thick; this piece was fixed between the wires. On stripping the core, a small puncture was discovered, as if made with a broach.

A third fault was of a more mysterious nature. The cable showed no appearance of being defective. When the external coverings were stripped off, and the core bared, a hole about the size of a pin's head was seen, filled with a whitish substance resembling glazier's putty. One wire of the internal sheathing was found severed exactly over this hole; the

external iron wire which lay immediately over was bent into a crook about two inches off. A small portion of the exterior serving was displaced in the region of the fault. On cutting through the core close to the fault, so as to expose the conductor, more of this soft, crushed, pasty matter was found. Two small fragments of hard bony substance were found in the interior serving. These bites showed traces of decomposition; but they were so small that it was difficult to say if the foreign matter was bone or scale. The fragments were somewhat fibrous and semi-transparent: there is little doubt, having regard to other signs, that they came from a fish. The white substance was certainly decomposed dental matter.

These three faults were all found within 15 miles of each other, about 130 miles from Para. A fourth one was found in the deep-sea type; and although no fragments of teeth were discovered in it, the distortion of the sheathing wires showed that it was due to the same cause as the preceding. A fifth fault, picked up 270 miles from Para, half way to Cayenne, was not so evidently caused by fish, although such is just possible. The core in this case was pierced as before, but this time the hole was filled with a black substance; the copper gave signs of indentations like teeth marks. The teeth must have been very strong to have freed themselves. Mr. Warren has told how that after these faults had been taken out, the cable was again interrupted in the following year with five more fish bites at about the same place. From one of these a piece of hard bony substance, an inch and a half long, was taken, while the piece still fixed in the cable was an inch in circumference. Mr. Warren was much puzzled to know by what fish these attacks were made, until arriving at Demerara, where he identified the teeth of the saw-fish, which abounds in those waters, and on all the northern coast of Brazil.

After the saw-fish, three insects may be mentioned whose misdeeds have been known some years, and which were described by Mr. Preece before the Society of Telegraph Engineers.

The *Teredo navalis*, and its congener, the *Xylophaga*, which Huxley discovered for the first time in 1860, in one of the Levant cables, lodge themselves in the hemp, penetrating even to the gutta-percha wherever an opening in the sheathing allows them a passage.

The *Teredo* is a worm which constructs a shelter in the form of a tube by secreting calcareous matter. The *Xylophaga* is a bivalve. The latter does not penetrate far into the gutta-percha; it only fixes one valve into it. In small cores this is sufficient to produce a considerable loss of current.

The *Teredo* and the *Xylophaga* are found in the Mediterranean, in the Atlantic, and even in the northern seas.

The *Teredo norvegica* is a worm of considerable dimensions, and is armed with bivalves in the form of shells, which enable it to gnaw the hardest wood. It belongs to the class of acephalous molluscs; naturalists count at least twenty-four different species.

The *Limnoria lignorum*, called also *L. terebrans* by Dr. Carpenter, is a little crustacean of the size of an ant, so that it can get through the interstices of the sheathing wires even of the best-made cable, and penetrate to the core, through which it burrows. In the Indian Ocean and the Persian Gulf, the *Limnoria* attains larger proportions, and effects excavations of considerable size. It is frequently met with on the shores of Ireland, where several cables have been seriously damaged by it.

To exhaust the subject, we will quote the part, which, according to M. Ternant, is played by the whale in accidents to submarine cables. During the laying of the first Atlantic Cable, in 1859, a whale very nearly broke the cable in crossing the stern of the *Niagara*. Another, and still stranger, adventure, is told of one of the Persian Gulf Cables, from Gwadur to Kurrachee. The accident, says M. Ternant, was of such an extraordinary nature that it is necessary to quote the official source of information.

Mr. Isaac Walton, superintendent of telegraphs for Mekran and the Persian Gulf, reports as follows to the Government at Bombay: "The cable from Kurrachee to Gwadur, about 300 miles long, was suddenly interrupted on the evening of the 4th inst. The telegraph steamer, *Amberwitch*, Captain Bishop, with the staff of engineers and electricians, under the orders of Mr. Hy. C. Mance, started next day to repair the fault, which was estimated to be 116 miles from Kurrachee, according to the tests taken from both ends.

"The *Amberwitch* arrived at this place at two o'clock on the afternoon of the 6th. The sea was rough, and there was a thick fog at the time, but the cable was nevertheless hooked at a quarter of a mile from the point of rupture.

"The soundings taken about the place of this break were very irregular, and showed a jump from 70 to 30 fathoms. In hauling in the cable an unusual strain was experienced, as if the cable had fouled a rock, but on persevering for some time, the body of an enormous whale, entangled in the cable, was brought to the surface; it was found to be firmly held by two and a half turns of the cable, taken immediately above the tail. Sharks and other fish had partly devoured the carcass, which was rapidly decomposing, the jaws coming adrift on arriving at the surface. The tail, which was 12 feet wide, was perfectly preserved, and was covered with numerous shells at its extremities. Apparently the whale had rubbed itself against the cable for the purpose of ridding itself of parasites, and had with a stroke of the tail, broken the cable, and, at the same time, so coiled itself up in it as to be strangled thereby."

We conclude, with M. Ternant, that this accident shows how important it is by a complete survey of the sea-bottom to avoid sudden inequalities of soundings near coasts. — Ch. Bontemps in *La Nature*.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

[The Report of the Proceedings of this Society is unavoidably postponed until our next issue, owing to the MS. having miscarried in its transit through the post.—Edit. Tel. Jour.]

PHYSICAL SOCIETY.—15TH DECEMBER, 1877.

Prof. G. C. FOSTER, President, in the Chair.

THE following candidates were elected members of the Society:—W. E. Ayrton, J. M. Cameron, J. W. Clark, J. E. Judson, B.A., H. N. Moseley, M.A., F.R.S., Lord Rayleigh, M.A., F.R.S., W. N. Stocker, M.A., and H. T. Wood.

Mr. C. W. COOKE read for the author, Prof. S. P. Thompson, a paper on "Permanent Plateau Films," and exhibited the process of their formation. After a brief enumeration of the various attempts made by Plateau himself, Schwartz, Mach, Rottier, and others, most of which are described in the work of Plateau, the author described his own experiments on the subject. As the result of these, he concludes that the best results are obtained by using a mixture of 46 per cent. of pure amber-coloured resin and 54 of Canada balsam, which should be heated to from 93° to 95° C. The frames for forming the films are made of brass wire 0·3 mm. in diameter, and when thicker wire is employed they are found to be irregular, in consequence of the retention of heat by the metal. The films are obtained by simply introducing these frames into the heated mixture, and they harden almost immediately on exposure to the air; but better results are obtained by slow drying in an air bath, heated up to 80° C., and allowed to cool. In proof of the toughness of the films, it was mentioned that a flat circular film 4 cm. in diameter had supported a 50 gramme brass weight at its centre.

Mr. SEDLEY TAYLOR then exhibited some experiments in illustration of a paper on the colours exhibited by vibrating liquid films which he has recently communicated to the Royal Society.

Dr. GUTHRIE exhibited a simple lecture illustration of the action of the telephone. Two similar coils of wire are placed one on the end of a bar magnet, and the other on a soft iron core. A tin disc, about 3 inches in diameter, is suspended by two threads almost in contact with one end of this latter, and when a similar disc is brought, at regular intervals, against the end of the magnet which is provided with the coil, a distinct movement of the first-named disc is observed, which can be easily increased by properly timing the movement of the inducing disc.

THE METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this Society was held on Wednesday, the 19th ultimo, at the Institution of Civil Engineers; Mr. S. H. Eaton, M.A., President, in the chair. Commander E. G. Bourke, R.N., J. A. Douglas, W. H. La Zouche, B.A., G. J. Pearse, W. S. Rogers, and W. Tyrer were elected Fellows, and eight candidates proposed.

The following papers were read: "Notes on the Meteorology and Physical Geography of the West Coast of Africa, from Cape Verd to the Cape of Good Hope," by Commander E. G. Bourke, R.N. This paper gives the results of the observations which the author made during the five years he was stationed on the above coast.

"On the Meteorological Observations made by the Norwegian Deep-Sea Exploring Expedition in the North Atlantic in 1876 and 1877," by Professor H. Mohn. This expedition has been organised in order to carry out for the North Atlantic and the Arctic Oceans an enquiry similar to that conducted by the *Challenger* Expedition. The vessel employed was the *Voringer*, of 400 tons burthen, and the period the summer months of 1876 and 1877. The barometrical observations were taken at first with a mercurial barometer, and afterwards with an aneroid, which was compared daily with the mercurial barometer on board. The temperature was obtained by a special screen hoisted upon the fore-stay. It was found that this gave very satisfactory results. The experiments conducted with a screen similar to that used by our Meteorological Office on ship-board, gave readings too high when the sun shone on it. The sling thermometer was also tried, and gave a temperature on the mean a shade below the screen in the rigging. The wind observations were taken with an anemometer, and Professor Mohn describes his own anemometer at length, and deals with its corrections in detail. The speed of the ship was determined by a special logging machine, and by this means and the anemometrical observations, the true motion of the wind was ascertained. The part of the paper which presented most novelty was that referring to the evaporation of the sea water. Two different forms of atmometers were described, both of them devised by Professor Mohn, and the theory of their action and of the errors to which the experiments were exposed are carefully considered. The paper concluded with tables of the diurnal range of the various meteorological elements for the period of observation.

Report on the "Phrenological Observations during 1877," by the Rev. T. A. Preston, M.A. As a rule the same order of flowering of plants is observed this year as in 1876, viz., that plants came into flower first in the South-West of England, and then in regular order to the North of Lincolnshire, where plants were latest in coming into flower. From the tables accompanying the report may be deduced the general state of the weather as regards temperature, and to a certain extent moisture. There is no doubt but that damp acts more powerfully than cold in retarding the flowering of some plants, and this has been particularly evident this year. The year, as a whole, has been very unfavourable to vegetation; the bitter cold of May checked the growth of plants, and by the autumn there was comparatively little new wood, and that not properly ripened.

Note on a peculiar Fog observed at Kew on October 18th, by G. M. Whipple, B. Sc., F.R.A.S.

Notes.

TELEGRAPHIC FIRE ALARMS are to be brought into use all over Paris. The alarm of fire will be given to the fire-engine stations by breaking a small pane of glass facing the streets.

THE telegraph office at the House of Commons is about to be connected to the Central Telegraph Office by a pneumatic tube. Hitherto, communication between these two places has been maintained by wire. The tube is formed of lead, enclosed in an iron pipe like those elsewhere in the city, and is of large capacity.

SIR WILLIAM THOMSON has been elected a foreign associate of the French Academy of Sciences, in the room of M. von Baer, by 27 votes out of 52. The other candidate was M. van Beneden.

A NEW company has been organised in the United States under the title of the "American Speaking

Telephone Company." It has contracted with the Gold and Stock Telegraph Company for the manufacture and introduction of telephones of the latest and most improved designs upon its numerous private telegraph lines in New York and the neighbouring cities, and elsewhere throughout the country. The Gold and Stock Telegraph Company has, by contract with the Western Union Telegraph Company, facilities for establishing such lines in all places where the Western Union Telegraph Company possesses lines.

IT is reported from America that the telephone of Mr. Richmond, of Lansing, Michigan, was tested on November 18th, through a wire between Lansing and Detroit, a distance of 230 miles, and worked very successfully. It is even said to be superior to that of Bell.

THAT eminent scientific authority *The Times*, at the conclusion of a report of a lecture on the telephone, given by Professor Barrett at the London Institution on the 27th ult., gives the following:—" Some interesting experiments were tried with the telephone at the Crystal Palace on Boxing-day. The main fact established was, that above the heads of 50,000 persons who congregated at the Palace, and the consequent noise created below, the operators at each end of the wire did not experience the slightest difficulty in carrying on a conversation with each other." This is certainly a most remarkable fact, and is likely to give the intelligent public a very clear idea of the way in which the telephone works!

MR. EDISON'S PHONOGRAPH.—The New York *Times* says that it is evident that this invention will lead to important changes in our social customs. The lecturer will no longer require his audience to meet him in a public hall, but will sell his lectures in quart bottles at fifty cents each; and the politician, instead of howling himself hoarse on the platform, will have a pint of his best speeches put into the hands of each one of his constituents. A large business will, of course, be done in bottled sermons, and many weak congregations which are unable to pay a regular pastor will be content with publicly opening a bottle of "Dr. Tyng," "Dr. Crosby," or some other popular ministerial brand, but the practice of personal preaching will be continued, since in no other way can a weekly opportunity be afforded to ladies for mutual bonnet inspection.

M. TROUVÉ has communicated to the Academy of Sciences, Paris, a plan whereby the undulatory currents produced in the line by a Bell articulating telephone may be intensified almost indefinitely. His plan is to multiply the number of vibrating diaphragms, so that the currents due to each shall unite their effects into a single undulatory current of multiplied strength. He therefore substitutes for the single diaphragm of a Bell telephone, a group of five diaphragms forming five sides of a cubical chamber, the sixth side being wanting. The mouthpiece opens into the interior of this hollow chamber lined with diaphragms. Each diaphragm is a vibrating surface, and acts independently of the rest upon its own coil and magnet. By associating all the currents produced by these magnets, a current is obtained of an intensity which is proportional to the number of magnets influenced. For the cube a polyhedron may be substituted, the faces of which are formed of an indefinite number of vibrating diaphragms, in order to obtain the desired intensity M. Trouvé's arrangement appears to be a cluster of telephones.

M. GRAMME, the inventor of the well known magneto-electric machine, has been made a Chevalier of the Legion of Honour. Twenty years ago, M. Gramme was, we believe, an *ouvrier*.

SPECTRUM OF THE ELECTRIC LIGHT IN GASES UNDER PRESSURE.—M. Weellner finds that there are two well defined classes of effect produced on the spectrum of the electric light in gases under pressure. In the case of hydrogen, the lines or bands themselves broaden out into a continuous spectrum. With other gases a continuous spectrum shows itself between the bands, which remain as definite as before. In the case of carbon compounds, and especially in that of carbon dioxide, the brilliancy of the continuous spectrum soon becomes so great that the bands are merged in it and cannot be distinguished; in nitrogen and air, however, they can be distinguished until the pressure becomes much more considerable.

CHLORIDE OF SILVER CELLS FOR SUBMARINE CABLE TESTING.—The remarkable constancy of the electromotive force and internal resistance of these cells, eminently fits them for the purpose of testing cables. The ordinary Minotto which is used at sea is subject to slight fluctuations, either of electromotive force or resistance when in action, so that in testing a lengthy cable by its means, the variations of the current running through the cable produce inductive "kicks," or sudden swings of the galvanometer needle, which materially interfere with the taking of observations on the scale. The chloride of silver cell is very much superior in constancy to the Minotto, and little, if at all, inferior to the Clark standard element in this respect. In fact it forms a practically constant battery. It is, moreover, small and clean, and can be packed into a space less than a quarter of that required for the Minotto or other form of Daniell. A set of twenty-five, for cable testing, may easily be framed in a neat box, which can be carried by hand, and in this form they would be suitable as a portable battery for electricians at cable stations. Even for signalling purposes they would be most advantageous, especially on cables. They are somewhat expensive to set up in the first instance, owing to the silver chloride

they contain, but as they reduce out pure silver which can be sold, they are not really expensive in the end. We believe that from eighty to ninety per cent. of the original cost can in this way be recuperated.

MAGNETISATION OF NICKEL.—M. Wild in a memoir to the Academy of Sciences, St. Petersburg, states the conclusion which he has arrived at from an examination of the magnetism of nickel, to be as follows:—1. Pure nickel, unlike pure iron, may acquire a considerable amount of permanent magnetism. The maximum amount of the permanent magnetism it can acquire is, however, only from one-half to one-third of that which hardened steel can receive. 2. The magnetism remaining in the nickel after the magnetising force ceases, is less permanent than in well-hardened steel; the slow and gradual loss of magnetism in the course of time, or the more abrupt loss due to heating and cooling, is proportionately greater than in hardened steel, even when, like steel, the nickel is brought by repeated warming and chilling into a ccrtain condition of permanence. 3. The temperature coefficient of a nickel magnet when in this condition is little greater than that of well-hardened steel. 4. The temporary magnetism which pure nickel acquires is about double that of its permanent magnetism; half that of the temporary magnetism which hardened steel can take; and a fourth of that which can be developed in soft iron.

MAGNETIC ROTATORY POLARISATION.—M. Henry Becquerel has recently published a lengthy memoir on this subject. His principal results are given in the *Ann. Chim. et de Phys.* v. xiii. 5, as follows:—1. That the positive rotation of the plane of polarisation of a ray of light having a definite wave-length, in passing through the unit of thickness of a diamagnetic material under the influence of magnetism, is sensibly proportional to $n^2 (n^2 - 1)$, a function of the index of refraction, and to a factor depending on the magnetism and on the diamagnetism of the body, this factor becoming the greater in proportion as the substances are more diamagnetic. 2. That with substances chemically allied or containing the same radical, the quotient of the magnetic rotation and the corresponding value of $n^2 (n^2 - 1)$ varies very slightly. 3. That the chemical nature of the substance exerts an important influence on the phenomena, so that the several constituents of a compound may produce an independent effect. 4. That when in solution the specific effect of the molecules of diamagnetic bodies is not influenced by the concentration of the solution, while that of the molecules of magnetic bodies may be greatly affected by the closer proximity which such a concentration would cause. 5. That when the substances are very diamagnetic, the dispersion of the rays caused by the magnetic rotation is sensibly proportional to $\frac{n^2 (n^2 - 1)}{\lambda^2}$, in which expression λ is the wave-length and n the index of refraction. The original paper also deals with the theory of M. Becquerel *père*, which refers the difference between magnetism and diamagnetism to the relative strength of the magnetic energy of the bodies experimented on, and that of the medium by which they are surrounded.

ELECTRICITY FOR SLEEPLESSNESS.—That galvanisation of the head has an hypnotic effect has long been known; hitherto, however, it has not been used to counteract sleeplessness. Vigoureux asserts *(Allg. Wiener Med. Ztg.)* that he has daily obtained the finest results in this direction, and has failed only in exceptional cases, as, for instance, when sleep has been disturbed or prevented by severe dyspnœa. His method is to place the broad, flat electrodes (carbon covered with chamois leather) on both temples, and allow the current of from three—at the most, five—Trouvé's elements to pass for a half or a whole minute. When the application is made in the morning the patient experiences a more or less pronounced inclination to sleep. Occasionally the effect of the galvanisation is prolonged after the first night, for a night or two.—*Scientific American.*

RESISTANCE OF AN ELECTRO-MAGNETIC RECEIVING INSTRUMENT.—The *Philosophical Magazine* for Dec., 1877, contains a mathematical paper by Professor Clausius on "A General Theorem respecting Electrical Influence," and also an interesting investigation by Mr. R. S. Brough on the best resistance to give to an electro-magnetic telegraph receiving instrument. Mr. Brough finds that in the case of a perfectly insulated and uniform line the resistance of the receiving instrument should be one-fifth of the resistance of the line, or

where $r =$ the resistance of the receiving instrument in ohms,
$l =$ the length of the line in miles,
and $k =$ its resistance per mile in ohms,
then $r = \frac{k\,l}{5}$

Singularly enough, this is the precise value selected on experimental grounds by Professor Hughes. Taking into account the resistance of the signalling battery, which is neglected in the result just given, the proper resistance for the receiving instrument becomes

$$r = f - \frac{k\,l}{4}$$

where $f =$ the total resistance of the battery.

M. JOURDAN has lately described a new single liquid battery to the French Academy. The electrodes are zinc and black lead, and are immersed in an aqueous solution of sal-alkali. It is said that the power of the battery is superior to that of Bunsen and its constancy is very great.

TELEGRAPHIC communication between Java and Australia has been restored.

THE SOCIETY OF TELEGRAPH ENGINEERS.—The next ordinary general meeting of this society is announced to take place on the 23rd inst., when the President elect, Dr. C. W. Siemens, will deliver his inaugural address.

IN an article to the December number of the *Nineteenth Century* on "Cheap Telegrams," Sir Julius Vogel makes the following suggestions by way of improving the present postal telegraph service:

1. A revision of the charges for ordinary telegrams, to embrace a reduction in the minimum number of words, and a logical recognition of the cost of free addresses and delivery, stationery, &c. The message should be ten instead of twenty words.

2. Subject to examining the length of present messages and making allowance for increased business on the one hand, and diminished length of telegrams on the other, the scale to be adopted to be ninepence for ten words, and threepence for each five words additional, or sixpence for each message, and a halfpenny for each word in excess of the signature and addresses.

3. That free names and addresses be still given.

4. That signatures to telegrams be required.

5. That a system of cheaper telegrams to be delivered by post be adopted.

6. That in connection with it the power of registering telegrams be afforded.

7. That a telegraph money order system be established.

AT a meeting of the Mersey Docks and Harbour Board, Mr. Glynn inquired how it was that when there was bad weather, which occurred nearly every month or six weeks, there was always an interruption of telegraphic communication between Liverpool and Holyhead. Mr. Holt said that the Marine Surveyor had remonstrated with the Postal Telegraph Department. There were considerable interruptions in November and December. There was one interruption which lasted from November 27th to December 1st; and this was owing to the breaking down of a bridge, and the wires being carried with it. On the 4th, 7th, 10th, 11th, 15th, and 20th December, the stoppages were continual in the early morning, simply owing to a collection of either spray, rain, or sleet, and until the sun had dissapated this, communication could not be carried on. The Marine Surveyor gave it as his opinion that subterranean lines would be disadvantageous. The most important communication of the whole—because life might be involved—was that with Crosby Lightship, and this had been put in thorough repair. Mr. Guion pointed out that the Board had communication with Point Lynas, independent of the Post Office; and though all the wires were on the same poles, they got information through the Marine Department, when the Post Office could not give it. Mr. Trellock mentioned that they received news from Point Lynas of the loss of the *Dakota* at the Marine Office, when they could not get it through the Post Office. It was agreed that a report should be brought up on the working of the whole system.

City Notes.

Old Broad Street, Dec. 31st, 1877.

IT looks as if Mr. Pender and his friends were going to be speedily undeceived in their fancy that they have acquired an absolute monopoly of telegraphic traffic between this country and America. Perhaps, however, they will be able to explain away the fact—at least, as the statement is published in a journal by no means hostile towards the Pender clique, we conclude it may be relied upon as such—that a bill has been introduced into the United States House of Representatives ostensibly to aid in the establishment of additional telegraphic communication between the United States and Europe, and for other purposes, "which purpose is to give a very liberal charter to the American Cable Company, in consideration of the free transmission of Government messages and their preference in point of time, and a reduction of two-thirds in the present rate of tolls for the public, provided that the number of words sent by the Government shall not exceed the highest number of words sent in any one year since ocean cables were introduced." We also learn that the charter proposes *to confer the exclusive right to land cables on the American coast.* Finally, it is provided "that five years after the said cable shall have been in working order between the city of New York and England and France, the rates shall be reduced to 20 cents per word, and at the expiration of eight years to 17 cents, in twelve years to 13 cents, and after fifteen years to 10 cents per word." We are quite aware that Mr. Pender has been laying the flattering unction to his soul that we were mere alarmists, anxious only to try and bring him into disrepute. To tell the truth, we do not care a straw about Mr. Pender personally one way or the other; we do care to interest ourselves in, and have interested ourselves in, the deluded shareholders of the united companies and the public—those shareholders who were to reap a harvest by the amalgamation, that public which was, by Mr. Pender's aid, to realise the benefits of cheap telegraphy. It will now be seen by the shareholders, and by the public no less than by Mr. Pender and his friends, that we did not prophecy vain things. We knew that it was almost as impossible for the latter to secure a monopoly of cable traffic to America, as for Canute of old to stay the course of the rising tide—the wonder is that anyone else thought otherwise. The announcement we have quoted from an American contemporary has caused us a little surprise, because we scarcely expected that the inevitable consequence of the policy pursued by the united companies would so soon come to pass. But nothing else was to be expected in the long run. We did construe Mr. Pender's silence on the subject of the threatened interference of the American Government with the Direct Cable as a suspicious circumstance, and if Mr. Pender had any idea of what was likely to happen, we can readily understand why he declined to commit himself to any definite declaration. Of course, it does not follow that because a bill is introduced into the American Conference it will be passed; but the terms of the measure are such as cannot fail to command wide approval. We shall wait

patiently to see if it obtains the sanction of the United States' Government. If it should be rejected, why, the evil day for Mr. Pender and those who have pinned their faith to his sleeve, will be simply postponed; while if it should, even with modifications, be accepted, then the time of tribulation will, indeed, have dawned for them. Imagine the position of the Direct Company if "the exclusive right to land cables on the Atlantic coast" be granted to some other enterprise.

By the way, what will the Globe Company do should another cable be laid across the Atlantic by an independent company? That something will have to be done in that case is obvious. We are inclined to think the Globe Company will certainly not let the shares, which, not so very long ago, were recommended as averaging the dividends and risks of telegraph investments, be depreciated still further in value without an immense effort. Will the directors issue fresh capital to poor widows who require a safe investment at 5 per cent., and buy up or amalgamate the new company with the old? We confess, absurd as it may appear, we should not be in the least astonished if, should a new company commence operations, negociations were at once set on foot by the monopoly wire-pullers with that end in view. Most people have an impression that the capital of the Anglo-American Company is ridiculously high already; but Mr. Pender and his supporters count hundreds of thousands as trifles light as air, and we dare say they have already begun to discuss the amount of fresh capital they may have to ask for. We could hardly commend such a step under any circumstances; but if the Globe Company and the companies which it has thrown its shield over get into a scrape, and investors like to assist them out of it—well, we cannot help it.

It is rather curious that the traffic receipts of the Anglo Company have, since the amalgamation, appeared to steadily increase, though, on the other hand, the traffic receipts of the Direct Company have appeared to steadily decline. Yet, before the amalgamation, the receipts of the Direct Company were increasing, and those of the Anglo Company declining. Is it possible that Mr. Pender—we really owe our readers an apology for mentioning his name so often, but it is unavoidable—intends to prove how kind he was in his terms to the Direct Company? The Anglo Company, it will be recollected, takes 75 per cent., the Direct 25 per cent. of the receipts, whatever the surplus of receipts may be over expenditure. How admirably some things are managed!

We know nothing of the Westminster Association, Limited, except that some of the individuals belonging to it must be very silly persons. The Westminster Association have forwarded to the proprietors of the Anglo-American Telegraph Company a circular urging that the reserve ought to properly bear the cost of expeditions sent out to recover cables. In other words, the members of the Westminster Association, being not unnaturally dissatisfied with the dividend paid by the Anglo-American Company, affirm that it is a great shame they should have to contribute toward the expenses of repairing their own cables. They fail to see, what everyone else of course perceives immediately, that the reserve fund of the Anglo Company is set aside, not for repairing, but for renewing cables. Whatever the Westminster Association may urge to the contrary, any expenditure incurred by the company in the way of repairs is most clearly chargeable to the current working expenses, and a demand that it should be paid from the reserve fund is either owing to impudence or to sheer ignorance. It would be as rational to argue that the salaries of some of the officials ought to be paid out of the reserve fund, as that repairing expenses—which will always occur every year—should be debited to it.

At an extraordinary general meeting of the Mediterranean Extension Telegraph Company held last week, resolutions, making alterations in the articles of association, by which the quorum for a general meeting was altered from twelve shareholders holding a thousand shares to eight shareholders holding the same number of shares, either in person or proxy, and reducing the maximum number of directors from seven to four, and the minimum from five to three, were, we learn, unanimously confirmed "without remark."

It is announced by the Eastern Telegraph Company that an interim dividend of two shillings and sixpence per share in respect of profits for the quarter ended September 30, is payable on the 14th of January; and a dividend of three shillings per share in the six per cent. Preference Shares, less income-tax, for the quarter ending December 30, will also be paid on that date. The directors of the Eastern Extension Company have declared an interim dividend for the quarter ended September 30 of two shillings and sixpence per share, or at the rate of 5 per cent. per annum.

We do not, as a rule, concern ourselves in the movements of Tramway Companies, which are somewhat beyond the scope of this journal. But the attempt now being made by the North Metropolitan and London General Omnibus Companies to unite deserves a passing word of notice. It is evident to all impartial observers that such a union would only be injurious to the interests of the public, unless both of the companies pledged themselves to certain things they are unlikly to agree to. For our own part, we are dubious whether amalgamation is seriously intended. There have recently been so many utterly unfounded rumours of amalgamation, that we are disposed to fancy it is a case of the Manchester, Sheffield and Lincolnshire Railway over again. At any rate, investors should, at this juncture, be very careful in purchasing shares in either of the companies in question, no matter at what price they are quoted in Capel Court.

General Science Columns.

THE ANNUAL GENERAL MEETING OF THE INSTITUTION OF CIVIL ENGINEERS.—The annual general meeting of the Institution was held on Tuesday, the 18th of December, for the purpose of receiving the report of the Council, and electing the president, vice-presidents, and other members of Council for the ensuing year. The report referred to the proposal, made in the report of the previous year, to separate the professional from the non-professional associated by creating a new class, under the title of "Associate Member," for those professional associates who were not qualified for the higher class of "member." This proposal, however, did not meet with the approval of a large number of associates who would have been affected by the change; and at a special general meeting held last April, after a long discussion, it was decided to abandon the proposal. The Council, however, considering that the matter was left in an unsettled and unsatisfactory state, and that the associate class should not remain in its present mixed form, has now pro-

posed to create a new class with the title of "Senior Member" or "Fellow." The professional associates would, according to this proposition, be transferred to the class of "Member," and the new class be reserved for the senior members of the society. The further consideration of this proposal is reserved for a special general meeting of members and associates. The only method by which we think the proposed change could be made acceptable to the existing members would be by transferring the whole of the present members into the new class; the title of member being conferred upon all the present professional associates, who could be transferred when properly qualified, to the higher class. The numbers of the several classes on the 30th of November, 1877, were:—Honorary members, 16, members, 925, associates, 1,670, and students 448, together 3,059, as against 2,844 at the same date last year, showing an increase at the rate of about 7½ per cent. The income of the Institution has nearly reached £10,000 a year; the "minutes of proceedings," of which four volumes are now annually published, cost in the past year nearly £5,200. The following is the list of gentlemen elected to fill the several offices in the Council for the ensuing year:—Mr. John Frederic Bateman, F.R.S., President; Mr. J. Abernethy, Sir W. G. Armstrong, C.B., F.R.S., Mr. W. H. Barlow, F.R.S., and Mr. J. Brunlees, Vice-Presidents; Mr. W. Baker, Sir J. W. Bazalgette, C.B., Mr. F. J. Bramwell, F.R.S., Mr. G. B. Bruce, Sir John Coode, Mr. W. Froude, M.A., F.R.S., Mr. G. F. Lyster, Mr. W. Pole, F.R.S., Mr. C. W. Siemens, F.R.S., Mr. D. Stevenson, F.R.S.E., Sir Jos. Whitworth, Bart., F.R.S., and Mr. E. Woods, members; and Colonel H. Hyde, R.E., Mr. J. P. Knight, and Major-General Scott, C.B., R.E., F.R.S., associates. In former years it has generally been the custom to re-elect all the old members of Council, and only add new members as vacancies occurred, but in this election this custom has been departed from, and though only one vacancy had occurred, owing to the President, Mr. G. R. Stephenson, having completed his term of office, four new members have been elected in addition to the three associate members who change every year. Though a change in a custom may seem hard upon those who are the first sufferers, yet it is well that the members of Council should not regard their re-election as a matter of routine; and the discretion exercised by the members should ensure the election, without delay, of eminent members when they are put forward, which will tend to promote the efficiency of the Council and confer additional distinction on those elected.

In the New Pyro-Hydrogen Lime Light, made by the Sciopticon Company, coal gas and common air mingle on the lime disc; prepared oxygen not being required. This is an important advantage, and the new light is likely to prove a convenience to those using Sciopticon or magic-lanterns, and to photographers in such operations as enlarging, copying, &c.

In support of the germ theory of zymotic diseases, such has cholera and typhus, it has recently been found by M. Bollinger that a certain incurable disease which affects the mouth, lymphatic glands, and stomach of cattle, is caused by a fungus which resembles common green mould.

Photographing by Artificial Light.—Mr. Van der Weyde, an American artist, has invented a means of enabling photographic portraits to be taken without the use of solar light, which is admitted on all hands to give highly satisfactory results, and which cannot fail to be of great service in our country where pure white daylight is so rare and inconstant. It is well known that the lime, magnesium, and electric lights, when employed directly as illuminators of the portrait model, produce photographs in which the light and shade are too strongly contrasted. This is due to the artificial rays radiating directly from a single point, whereas, solar light is diffused in the atmosphere. The diffused white light reflected from a cloud surface is regarded by photographers as a superior kind of light; and it is this source that Mr. Van der Weyde's artificial arrangement most resembles. A powerful electric beam, from a Siemens' magneto-electric machine, is thrown upon a concave parabolic mirror and reflected in parallel rays, which are then refracted to a cone of rays by a large lens. In this cone of rays, at or near the focus, the model sits, and excellent portraits can be obtained by an exposure of less than thirty seconds. By this method the light seems to become diffused, so that sudden light and shade is avoided; the portraits produced being soft and delicate in quality and highly natural in artistic effect.

Sensitive Reaction of Alumina and Magnesia by Spectrum.—M. H. W. Vogel finds that when a small quantity of an aluminum salt is added to a solution of purpurine in water very slightly alkalized by ammonia, the liquid takes a beautiful red tint and offers two strong absorption bands between the lines D and E and B and F; often a third more feeble band is noticeable towards F. If the concentration of the liquid is too great these bands unite into a single one.

To detect aluminum, to 2 cubic centimetres of the solution containing aluminum, which ought to be neutral, add 3 drops of an alcoholic and saturated solution of pure purpurine, and then a drop of ammonia diluted with four volumes of water.

In presence of very small quantities of ammonia, less than one-tenth milligramme, the absorption bands shew themselves after several minutes. One drop of dilute acetic acid is without influence on the intensity of the bands; an excess of acetic acid enfeebles them without causing them to disappear altogether; an excess of tartaric acid or of a mineral acid destroys them, but they reappear when the liquid is neutralised.

Magnesia offers with purpurine a reaction quite

analagous to that which alumina gives, but the bands which it furnishes, disappear under the influence of the least quantity of free acetic acid.

Magnesia and alumina can be detected by this reaction even if they are in presence of organic matter, or of ammoniacal or alkaline salts. Salts of iron and zinc forbid the reaction and must therefore be eliminated. This can be done by adding to the solution an excess of tartaric acid, then ammonia, and at last sulphhydrate of ammonia; the iron and zinc are precipitated, the filtered solution supersaturated with chlorhydric acid boiled, filtered a second time and neutralised, is ready for the direct test for alumina and magnesia.

In presence of certain salts the purpurine precipitates itself in the state of alumina or magnesium flakes and escapes the examination of the spectroscope; in this case the flakes are separated by infiltration, dissolved in acetic acid and neutralised by ammonia.

M. Vogel also finds that purpurine is often adulterated with cochineal which is deleterious to the reaction. In order to detect cochineal it is sufficient to agitate the aqueous solution of the dye with ether. The ether engages all the purpurine, whilst the carmine remains in the aqueous solution.

M. Von Lepel has confirmed in general these results of M. Vogel, and has added some new observations of his own. He points out that the disappearance of the magnesian bands under the influence of a small quantity of acetic acid, is the simplest means for distinguishing the bands of alumina.

He finds that large quantities of lime exercise a disturbing influence on the reaction, for the lime salts gives in presence of water two absorption bands, large but feeble, separated by a clearer part situated towards E *b* and capable of masking the magnesian bands. Also a mixture of equal parts of magnesia and lime gives a spectrum at every point analogous to that of a mixture of alumina and magnesia. The major part of the lime ought therefore to be eliminated, and this can be done by precipitating by Seignette's salt the liquid already mixed with purpurine, and examining it directly by the spectroscope, when the precipitate has settled, which takes place after some minutes. When the quantity of lime is less than 0·0008 gramme per cubic centimetre of the solution, it exerts a good rather than a bad influence on the test.

By means of the spectroscope, M. Von Lepel has been able to detect small quantities of magnesia in the watery humour of the eye, in whey, in the urine of man, and different domestic animals, the bile of cattle, the stems and leaves of plants, the juice of the apple and pear, in flax seed, &c.—*Deutsche Cehmische Geselschaft.*

THE Royal Society has awarded a Royal Medal to Mr. Frederick Augustus Abel, F.R.S., president of the Society of Telegraph Engineers, for his physico-chemical researches on gun-cotton and explosive agents. The Davy Medal, a bequest of Sir Humphry Davy, and now given for the first time, was awarded Messrs. Kirchoff & Bunsen for their researches and discoveries in spectrum analysis.

CESSPOOLS.—Dr. F. Erisman has found eighteen cubic metres of excrement, such as is ordinarily met with in cesspools, to give off in twenty-four hours

11·144	kilogrammes of	carbonic acid gas,
2·040	"	ammonia gas,
0·033	"	sulphuretted hydrogen gas,
7·464	"	carburetted hydrogen gas;

making in all 20·681 kilogrammes, or about twenty cubic metres of unbreathable gas. Dr. Erisman deems copperas and sulphuric acid the best disinfectants. Herr Ecktein considers chloride of lime the most powerful deodoriser for cesspools, and proposes to use it wrapped in parchment paper, whereby its action is prolonged. He considers copperas and sulphuric acid as defective, because of their brief action, which extends only over one day or two, whereas chloride of lime operates for a week. He found liquid sulphuric acid to act almost immediately, but it was oppressive to breathe, and after twenty-three hours it was exhausted. A kilogramme of copperas in a bag of parchment paper only began to act after two hours, but continued effective for three days. On the other hand, a kilogramme of chloride of lime in parchment paper acted powerfully for nine days. The place operated upon was a public privy used daily by at least a hundred persons. Herr Ecktein regards chloride of lime and sulphuric acid as the most powerful deodorisers known.

PRINTING types of hardened glass have been found to work admirably on the revolving press with continuous paper, and may possibly come into general use.

ANCIENT RUINS IN COLORADO.—Dr. Hayden, of the United States Geographical and Geological Survey, has recently discovered some very interesting ruins of a vanished people in the Valley of the Animas, South-western Colorado. The finest of these ruins and the most perfect are situated about thirty-five miles below Animas City in a large valley on the west side of the river. This valley has at one time been covered with buildings of all sizes, the two largest being 6,000 by 300 feet, standing about 300 feet apart, and exactly similar. They are built of small blocks of sandstone, laid in adobe mud, the outer walls being four feet, and the inner walls from a foot and a half to three feet thick. In the lower storey of the outer walls are found port-holes a foot square. Several rooms are still left, and walls reaching four stories high are still standing. About the second storey on the west side there was once a balcony along the entire length of the building. No signs of a door are visible in the outer walls, and the entrance must have been from the roof. Inside there are passages from room to room. Most of the rooms

are small, from 8 by 10 to 12 by 14 feet, the doors being 2 by 4 feet. The lintels over the doors and portholes are made of small cedar poles, two inches wide, placed across, on which the masonry rests. The joists supporting the floor are of cedar, about 8 inches thick, 20 to 50 feet long, and about 3 feet apart. A layer of small round poles has been placed across the joists, then a layer of thinly-split cedar sticks, then about 3 inches of earth; then a layer of cedar bark, then another layer of earth, and finally a carpet of some kind of grass. The rooms that have been protected from exposure are whitewashed, and the walls are ornamented with drawings and writings. In one of the rooms the impression of a hand, dipped in whitewash, on a joist, is as plain as if it had been done yesterday. In another room there are drawings of tarantulas, centipedes, horses, and men. Human bones have been found, bones of sheep, corn-cobs, raw hides, and various kinds of coloured pottery-ware. Portions of the buildings show that they have been destroyed by fire, the timbers being burned and the roofs caved in. The stone which these buildings are built of must have been brought a long way, as nothing similar can be found within a radius of twenty miles. The timber used is all of cedar, now only found twenty-five miles off. Old ditches and roads are to be seen in every direction. The Navajo Indians say in regard to these ruins, that their forefathers came there five old men's ages ago (500 years), and that these ruins were here, and the same then as now; and there is no record whatever of their origin.

BOILER EXPLOSIONS BY DECOMPOSITION OF STEAM.—At the recent meeting of the American Academy of Sciences an apparatus was shown at work which proved that steam might be decomposed by simple heat into the constituent gases of water—oxygen and hydrogen. The heat employed was a little over ordinary redness, but did not reach whiteness. This experiment is of the highest value, as illustrating a possible cause of boiler explosions. The apparatus was very simple—a flask in which water was heated, a tube conveying the steam into a closed platinum crucible, where it was again heated by a spirit lamp, a tube thence carrying the super-heated steam and the liberated gases to an ordinary pneumatic trough, where the mixed gases were collected in a test tube, while the steam was absorbed. At the conclusion of the experiment the gases thus collected were exploded by a lighted match, showing beyond question that they were the components of water. The experiment indicates that this explosive mixture of gases may be formed in a steam boiler. But it can only result from the most culpable carelessness. The boiler must, at least in part, be raised to a full red heat. Then cold water must be injected, for so long as steam and gases are mixed the latter cannot explode. The injection of water must condense the steam in the boiler before it cools the red-hot iron. All these conditions being fulfilled, an explosion of the gases may take place.—*The Polytechnic (American) Review.*

PHOTOGRAPHING IN NATURAL COLOURS.—Herr Joseph Albert, the eminent photographer of Munich, is said to have accomplished this crowning problem in photography by a combination of the ordinary photographic process with his photographic printing-press. The finest shades of colour are said to be faithfully reproduced without any resort to the brush. Three negatives are taken for each object, and finally blended together. The first negative is taken on a plate chemically prepared to receive only the yellow tints of the object; this is then passed through a printing-press, which has its roller dressed with yellow colouring matter, and a print showing only the yellow portions of the object is the result. A second negative is taken with the blue light from the object, and printed off by a second press having a blue roller. A third negative is taken with the red light from the object, and similarly printed off in a press having a reddened roller. The three images so obtained are then printed on the same plate, when the colours blend, producing the natural tints and shades of the object.

VOLATILISATION OF LIQUIDS IN A GAS.—M. Kirchman has observed that the volatilisation of certain volatile substances is retarded or forbidden in an atmosphere of carbonic acid, whilst others become more volatile in this gas. Camphor, chloroform, and sulphuret of carbon are hardly volatilised at all in carbonic acid. Ether, ethylic, methylic, and amylic alcohols, as also water, are more volatile in carbonic acid than in air. If a rapid current of carbonic acid is directed over the surface of ether, the exterior of the vessel holding the ether is covered with a coat of frost, which does not appear when a current of air is employed. Alcoholic ether is rapidly deprived of ether by a current of carbonic acid gas. In general, dry carbonic acid furnishes an excellent means for separating essential oils from the water which accompanies them in their extraction.

WHITENING OF LAC.—The following account of Kressler's method of whitening lac, as modified by Sauerwein, is given by *Dingler's Polytechnischer Journal.* Ten parts of pounded lac are dissolved by heating, with four parts of crystallised soda, in 120 to 150 parts of water in a copper basin, and the violet solution (the colour of which, according to Marquart and Esenbeck, is due to a colouring principle analagous to carmine) is filtered in a wooden vessel through linen. Into this solution is then filtered another, formed by adding ten parts of chloride of lime (containing about 30 per cent. of chlorine) to a solution of ten or twelve parts of crystallised soda in 200 parts of water. To the mixed solution is added with care some cold chlorhydric acid, diluted, until little lumps of lac begin to precipitate; a small quantity of acid generally suffices. At the end of two or three days the whitening is complete, and the lac is then to be precipitated by adding concentrated chlorhydric acid. If the lac is

tolerably pure, the white precipitate can be immediately reunited on a piece of coarse linen, washed several times, and melted. When the lac is impure it must be allowed to stand several hours in the liquid along with the chlorhydric acid. The chlorine set free acts very energetically; nevertheless, it is preferable to allow the solution of chloride of lime to act on the alkaline lye. When the finely-divided lac remains a long time in the acid solution of chlorine it becomes brittle, and does not spread well. The precipitated lac is put into boiling water, which softens and permits it to be moulded; it is at first porous and opaque, but on warming it several times, and kneading and flattening it, a silky lustre soon begins to appear.

ARTIFICIAL OPAL.—To prepare artificial opal, M. Monnier takes a thick solution of silicate of soda, and places upon it a very dilute solution of oxalic acid. By endosmose the two liquids slowly mingle, oxalate of soda being produced and silica set free. But instead of taking the gelatinous form which it ordinarily assumes after a quick double decomposition, the silica deposits itself on the walls of the vessel in masses which have a density and rigidity like natural opal. On substituting sulphate of nickel for the oxalic acid, M. Monnier obtained a green opal which appeared analagous to the silicious mineral, in which nickelliferous ore is found. In treating by the same process the sulphate of alumina by a solution of ammonia, a very hard hydrate of alumina was obtained, which adhered rigidly to the walls of the vessel in which it was produced.

PROFESSOR TYNDALL ON GERMS.—Dr. Tyndall, in a recent lecture at the London Institution, Finsbury Circus, stated that he had forwarded sixty hermetically sealed glass flasks, containing infusions of cucumbers, turnips, beef and mutton, to the Alps, and on arriving there, he had found six of the infusions muddy with bacterial life, while the rest remained clear. On examining these six tubes he found the glass broken, whereas the others were intact. He was of opinion that germinal matter had entered the six broken flasks with the air. In order to see whether the air itself could not produce germinal energy in the infusions, he exposed twenty-three open flasks to the air of a hay-loft, and twenty-seven to the pure air of the mountains. At the end of three days, twenty-one of the twenty-three left in the hay-loft were found to be crowded with infusorial life, while not one of the twenty-seven left in the mountain air showed signs of life. He was of opinion that it was not the air, but something in the air which produced the life observed; and that if an infusion could be exposed to sterilised, moteless air, it would never putrify, nor would meat so heated ever putrify. It is supposed by some that air sterilised by heat would be insufficient for life. Dr. Tyndall has invented a simple apparatus by which air sterilises itself. It consists of a box with glass panels, the inside being rubbed with glycerine. The air is admitted into this box, and the particles in it fall by gravitation and stick to the glycerine, so that in time a condensed beam of light shows that the air is optically pure. For more than a year upwards of fifty infusions had been exposed to the air in this apparatus, and they were as sweet and transparent as at the time they were introduced, while similar infusions, exposed to ordinary air, were in two days swarming with bacterial life. Dr. Tyndall also showed that a mineral solution containing all the materials necessary for building up bacterial creatures could not be fertilised by the eggs of germs, such as float in the air, or adhere to hay, but was capable of being inoculated by live infusoria from infected solutions. On the other hand, vegetable infusions, such as turnip water, could be fertilised both by floating air germs or eggs, and by the living infusoria. Dr. Tyndall is of opinion that the mineral solution can feed the infusorial "chick," but cannot hatch the egg. The living bacteria are very sensitive to heat, whereas the eggs are hard and dessicated, and will germinate after eight hours boiling. Dr. Tyndall killed sterilised infusions by heating them from time to time as the eggs developed into living bacteria, until there were no more left.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In your review of "The Application of Electricity to Railway Working," by W. E. Langdon, we notice you mention Walker's, Spagnoletti's, Siemens' and Preece's systems of block telegraphs; but totally ignore Tyer's. As this latter system is more extensively adopted in this country than all the others put together, we can only infer that your reviewer was unacquainted with their existence; we beg, therefore, to hand you a list of Railway Companies who have adopted Tyer's apparatus, and to inform you that considerable extensions of the system are being constantly made, and in some cases to the displacement of other apparatus mentioned in your review.

We trust to your sense of fair play to insert this communication, in order that Mr. Langdon's valuable work may in its review be as impartial as the author in his text. Faithfully yours,

Dec. 18th, 1877. TYER & COMPANY.

[WE are sorry that Messrs. Tyer's system should have been omitted in the review referred to; the omission was quite unintentional. We congratulate Messrs. Tyer on the success which they have attained.—EDIT. TEL. JOUR.]

SIR,—Will you have the kindness to inform me if a pamphlet regarding the telephone has appeared lately? If so, you will oblige me by replying to this question in your next number. The extracts in your journal give me the desire to have a more detailed account.—Your obliged servant, PAUL ARNAUNE,

Employé du Télégraphe, Toulouse.

[We understand that a full description of the progressive steps by which the present form of Professor Bell's telephone was arrived at, will be published in the forthcoming quarterly number of the "Proceedings of the Society of Telegraph Engineers," which you will be able to obtain at Messrs. Spon, Charing Cross, London. We are not aware that any pamphlet or book has yet been published on the subject.—EDIT. TEL. JOUR.]

THE TELEGRAPHIC JOURNAL.

Vol. VI.—No. 119.

WORKMANSHIP.

It is a common complaint at the present time that English articles of workmanship are not what they ought to be, or, at least, are not what they might be. It is even said that we are gradually falling back from our front position as a manufacturing nation, and that unless some change for the better occurs we shall be inevitably outstripped in the race by other nations with more science and abler workmen. That there is too much truth, both in the complaint and the foreboding, cannot reasonably be doubted. The logic of facts and figures shows that our trade is leaving us for other countries, and the lamentable prevalence of faulty workmanship is within the personal experience of everyone. That telegraph manufacture is no exception to the rule is a point we will not dispute. Various causes have been assigned for this declension in the quality of manufactured articles. The merchant has been blamed for it, the manufacturer has been blamed for it, and so has the workman. The probability is that all three are to some extent culpable, and perhaps the public too. But to go no further than those concerned in the production of an article for sale, the merchant is said to aim at buying cheaply, no matter what the quality may be; and the manufacturer is obliged, by close competition, to cut his prices so low, in order to undersell his rivals, that he cannot turn out a good article unless at a loss. The case of the workman seems a little more complicated, and we believe it is the main cause of the evil, and that, as such, the remedy ought to be chiefly applied to him. Whether it be due to the short apprenticeship system, the introduction of machinery, the specialising of work, whereby a man is kept doing one thing and is degraded into a kind of machine, working forever in one groove, or whether it be due to subtler social causes which have given him a distaste for manual labour, the fact remains that the average workman cares little whether his work is well or indifferently done; provided it passes muster, and that he draws his weekly pay right enough, he is satisfied. He has little or no interest in his work, except in so far as it helps to pass the time till the six o'clock bell rings, when he may get home to tea and go to the music hall. That sense of satisfaction, which doing the work for its own sake brings with it, and which might be a never failing sweetener of the artizan's lot, seems entirely lost to him.

It needs no argument to prove that bad work is hurtful to all concerned, maker, seller, and user. In electrical work, faulty apparatus is especially annoying and troublesome to the user, because the defect is often difficult to discover, and at foreign stations it is sometimes all but impossible to rectify it. The seller, if he only believed it, is sure to suffer in the end by sending out bad work; but the most harm is done to the man who makes the faulty article—to the workman. He becomes morally deteriorated; and each flaw in the work makes a flaw in the workman. Can a man respect himself or be respected when he knows that he is making a sham? Can he have any satisfaction in his work when he is scamping it, or can he look back with pride upon it when he knows that it contains even one hidden defect? He can have no taste in bad work, and while he is doing it the day is a wearisome drag, and worse than a drag, for it is a penalty, the penalty of doing bad work. Good work on the other hand is lightsome work. No music hall "comique," not even the Inimitable Mackney, or the Jolly Nash, can afford a workman the deep satisfaction of a day's work well and conscientiously done. If a workman, instead of grumbling at his master, or his master's affairs, and looking forward to his pay-day, and his release from duty, were to give his whole mind to his work, both the work and himself would be the better, and both his master and the public would profit by it. During the middle ages work for its own sake appears to have been a canon amongst artizans; and it is to the operation of such a principle that we owe our great mediæval cathedrals, in which every stone is properly squared to fit its bedding, and properly placed there, whether it be a stone that can be seen or no. The work which is governed by a love of truth, like that which animated the mediæval workmen, is a benefit to all concerned, maker, seller, and user. The canon of the modern working men appears to be work for the money's sake, and his highest skill seems to be exerted in hiding imperfections.

If the loss of this craft spirit, this religion of work in the heart, is the most apparent and one of the chief causes of the prevailing indifferent workmanship at the present time, it becomes important to know the means which may be taken to restore it. There can be no doubt but that it ought to be restored, and the sooner the better, since we cannot have really good work without it. Until a workman loves his work and takes a pride in doing it thoroughly and well, neither good pay nor strict overseering will secure first-class execution. In all work of an artistic kind a workman may be

educated into a real love for it by inculcating a love of beauty and teaching him the principles of art. His aim then becomes to shape his work in accordance with these principles, and to make it as beautiful as he can. The closer he can bring it to resemble his ideal, the higher is his satisfaction and the better is the quality of the work. In the mechanical arts beauty is of secondary, fitness is of primary, importance. The mechanician then should be trained to understand the fitness of machines. He ought to be taught the principles of dynamics, and any other special science bearing on his work, so that he may be able intelligently to appreciate his work. In the making of electrical apparatus, not only is a general knowledge of the elements of dynamics desirable, but also a special knowledge of the elements of electricity. No kind of apparatus is so confusing and incomprehensible as electrical apparatus to a person who does not know anything of the nature of electricity; yet the men who make them, as a rule, know nothing of electricity. On the other hand, a knowledge of the elementary laws of electricity renders most electrical apparatus easy to understand. Can we wonder that glaring blunders are made in constructing electrical instruments, connections wrongly made, wires badly insulated, by a workman who knows nothing of the science of electricity. Need we be surprised if he takes little interest in his work when he does not understand it, and is obliged to copy the drawing in a slavish, unintelligent, fashion?

It is for the benefit of the manufacturer, as well as the workman, that the latter should be taught the principles of his work. We wonder how much money might be saved yearly to makers of telegraphic apparatus if all their workmen had a clear knowledge, without going further, of the fundamental distinction between insulators and conductors, and what substances were insulators and what conductors. There is a growing demand for technical education in the country, science classes for working men are becoming more and more common, and in time, no doubt, the general standard of workmanship will be raised, as these remedies can be brought to bear upon it. At present, however, there is a certain remoteness about them, they are rather for the growing than the grown generation. Must the latter, then, continue in ignorance because they cannot go to school again? There is a way by which the school may be brought to them. If manufacturers were to take the matter in hand, useful lectures and classes might be got up for the benefit of their workmen, and also, indirectly, of themselves. If, for instance, a manufacturer of electric telegraphic plant and apparatus, were to organise a course of lectures on the elementary principle of electricity and telegraphy, for the benefit of his workmen, it could not fail to benefit himself also. The lectures, should, if possible, be held during the winter months in a room of the works. They could be delivered by one of the electricians attached to the establishment, and the experiments could be designed to illustrate the special work done on the premises. By giving his men an understanding of their work the manufacturer would tend to diminish the undebited but dead loss due to blunders, and turn out a superior article to his customers.

WERDERMANN'S ELECTRO-MAGNETIC ENGINE.

ALTHOUGH many attempts have been, and are being, made to obtain motive power by means of electricity, but very little success can be said to have been attained. As an economical source of power, electricity cannot by any means be said to have established itself, and there does not yet seem any prospect of its doing so. It is not necessary here to enter into any details concerning the relative costs of motive power, produced by the combustion of coal in a steam engine, or of metals and acids in a battery, the extreme unfavourableness of the comparison, as regards the latter, is too well known to need repetition. It is quite possible that considerable use may be made of waste chemical products for producing electricity to obtain motive power, but such cases must be comparatively few, and but very lightly touch upon the general question.

There is, however, a question in which electricity will assuredly play, ere long, a very prominent part, and that is in the "conveyance of motive power to a distance." Should this problem be satisfactorily solved, the enormous sources of power produced by the operations of nature, in the ebb and flow of the tide for instance, which are useless to a great extent, because these operations take effect at places far removed from localities where the power is most required, would be laid under tribute.

The problem has, to a very great extent, been solved by the very great success which has been attained in the means for producing dynamic electricity in the machines of Siemens, Gramme, &c. Given the motive power, we have here the machines necessary and able to convert it into dynamic electricity; the conveyance of the latter to a distance is only a question of stout insulated metallic wires or rods, and it possesses no points of great difficulty. There only remains then the machine to reconvert the electric stream into motive power, and the question is in a very fair way to be solved.

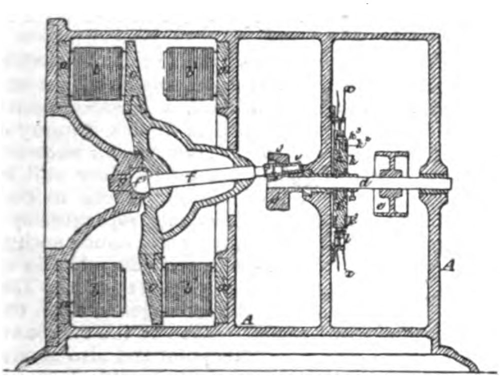
Among the many attempts that have been made in this direction, may be noticed the machine of Mr. Werdermann which possesses several points of novelty worth being pointed out.

In this machine three or more electro-magnets are arranged in a circle with their axes parallel to a main shaft which traverses the centre of an iron plate or disc, on which are fixed the electro-magnets.

In front of the poles of these electro-magnets an oscillating armature, preferably in the form of an obtuse cone, is arranged, provided at the apex with a short shaft and in the centre of its basis with a spherical bearing or universal joint. The shaft fits in a bush of copper or brass, or any other suitable non-magnetic material, fitted to the crank arm which is keyed on the main shaft, while the spherical bearing, made of non-magnetic material, enters a hole cut out at the apex of another disc which is connected with the frame of the apparatus.

On the main shaft is fixed a driving pulley. The shaft also carries a current breaker, which consists of two discs of ebonite or lignum vitæ, or other suitable non-conducting material, a segment of each being replaced by copper or brass, or other suitable conducting material, and connected with a ring of copper. The two discs are insulated from each other and are in contact at the periphery, each with as many springs, rollers, or rubbers as there are electro-magnets. The periphery of each ring is in contact with another spring, roller, or rubber, one of which is connected with the positive and the other with the negative pole of a galvanic battery or other generator of electricity.

The electric current flows through the rings,



segments, rollers, and the coils of the electro-magnets, which in succession, singly, or in series, attract the conical armature, thus forcing the crank pin to move in a circle, or, rather, to develope a cone, through the axis of which passes the main shaft, imparting to it a rotary motion.

The current or contact breaker is adjusted in such a manner that at the moment when one of the electro-magnets is in contact with the cone, the circuit is broken, the contact rollers passing from the copper segment to the insulating surface of the ebonite discs.

In order to obtain the largest possible surface, the polar extensions may be cut obliquely, so that their surface may have the form of an ellipse, or the cone may be provided with as many hemispherical or other projections as there are electro-magnets, the polar extensions of which must be concave or otherwise suitably formed to receive the said projections.

By preference, electro-magnets of a novel construction are employed in the machine; they are composed of an iron cylinder or tube fixed on a bottom plate, coiled with copper wire, or ribbons, or sheets of copper, and placed inside another iron tube, which is also coiled with copper wire, but in an opposite direction, so that the outer tube assumes opposite polarity to that of the inner tube; or, between two concentric tubes of suitable diameter, coiled with copper wire in such a manner that they have both the same polarity, may be inserted a series of cylinders or smaller tubes, coiled with copper wire in such a manner that the cylinders or tubes have all the same polarity, but an opposite polarity to that of the two large tubes, between the peripheries of which they are placed. The two concentric tubes are always magnetised, in fact, they may be permanent magnets, while the smaller magnets are magnetised or demagnetised in succession.

The figure shews a longitudinal section of the engine.

A is a frame of cast iron or other suitable material; *a*, a^1, are discs or plates forming part of or secured to the frame. The disc *a* carries one series of electro-magnets *b*, and the other disc a^1 carries another series of electro-magnets b^1; *c* is the armature; *d* is the main shaft of the engines; *e* is a driving pulley on the shaft.

Two series of three or more electro-magnets *b*, b^1 are employed, arranged in a circle, with their axes parallel to the main shaft *d*. Between the poles of these two series of electro-magnets, the oscillating armature *c* is arranged, which is preferably of the form shewn, and is provided with a central shaft *f*; one end f' of this shaft projects from the centre of the base of the armature *c*, and is fitted into a bearing *g* in such a manner as to form therewith a universal joint. This bearing *g* is formed of non-magnetic material, and is secured in a part of the frame as shewn. The other end f^2 of the shaft *f* fits in a bush *i* of copper or brass or other suitable non-magnetic material connected with a crank arm or disc *j*, which is keyed on the said main shaft *d*.

The main shaft, besides carrying the driving pulley *e*, also carries a current breaker *k*, which consists of a disc k^1 of ebonite or lignum vitæ or other suitable non-conducting material; a segment of this disc is removed, and replaced by copper or brass or other suitable conducting material as shewn at k^2, and connected with a ring k^3 of copper. The communicator *k* at its periphery is in contact with as many springs, rollers, or rubbers *l*, as there are electro-magnets in each series. The periphery of each ring k^3 is in contact with another spring, roller, or rubber, one of which is connected with the positive and the other with the negative pole of a galvanic battery or other generator of electricity.

The electric current flows through the said rings, segments, and rollers, and the coils of the electro-magnets, *b*, b^1, which in succession, singly or in series, attract the conical armature *c*, thus forcing the end f^2 of the shaft *f* to move in a circle, or rather to develope a cone, through the axis of which passes the main shaft *d*, and thereby impart a rotary motion to the said shaft.

The current or contact breaker *k* is adjusted in such a manner, that at the moment when one of the electro-magnets is in contact with the oscillating armature the circuit is broken, the contact roller passing from the copper segment to the insulating surface of the ebonite disc.

AN INTERNATIONAL TELEGRAPHIC TARIFF.

WITH the commencement of the new year came into operation the provisions of a convention between France and Germany, under which an important reduction in the international telegraphic tariff in Europe is made. Henceforth the charge per word between the contracting states, irrespective of distance, will be but twopence.

That this reduction will prove a boon to the public, does not admit of doubt; that it will enable the service to be carried on without pecuniary loss is another question which time only will enable one to see.

Although the arrangement has as yet been only adopted by the two powers in question, it is highly probable that their example will be followed by other states, and eventually, no doubt, by all the Continental powers. Whether England will come to be included amongst the number it is difficult yet to say; the interests of the Submarine Company, who own nearly all of the cables connecting Great Britain with the Continent, will considerably complicate the question. It is not to be supposed that the valuable property which that company possesses will be yielded by them for a small sum, and it would require a heavy subsidy to be paid them out of the public pocket, if the tariff for the work which passes through their lines is reduced, so as to allow such a low rate as twopence per word to be adopted. It is hardly reasonable to suppose that such an arrangement will yet be thought of; the adoption of an international postal tariff, we should think, must come first, and there are as yet no tangible signs of such an innovation being brought about.

The arrangement which has just been adopted is the practical outcome of the conventions which have been held at Paris, Rome, and St. Petersburg. The extension of the principle will no doubt form a prominent topic of discussion at the assembly, to be held in the middle of the present year, and the meeting will, therefore be looked forward to with much interest.

A SKETCH OF THE DEVELOPMENT OF THE ELECTRIC LIGHT.

By J. MUNRO, C.E.

(*Continued from page* 6.)

For the purposes of general illumination, however, a marked advance has been made in the electric light within the last five years. In 1873, M. Lodighin, a Russian engineer, made a public trial in St. Petersburg of a very successful light of his invention. Lodighin's plan* consists in enclosing not two but one stick of carbon in a hermetically sealed glass tube from which all air has been exhausted, and an azotic gas, such as nitrogen, let in. The object of excluding the air is to avoid all combustion of the carbon. The current is simply passed through the carbon, which becomes white hot, especially at the central part, which is narrower than the rest, and emits a steady and brilliant light. The carbon is not oxidised, and remains unconsumed; the enclosed light is unaffected by currents of air. It will burn equally well under water, and there is no danger with it in explosive mines; the current can be strengthened or weaked at will. The circuit is complete through the carbon, and a number of lights may safely be included in one circuit. One machine, worked by a 3-horse-power engine, is able to supply many hundred lanterns.

At first the carbon stick was grasped by metal holders; but the unequal expansion between the metal and carbon caused sparks to pass between the carbon and the enlarged sockets. M. Kosloff, of St. Petersburg and London, the proprietor of the patent, substituted insulating supports of china, clay, crystal, &c., with metal wires introduced to put the carbon in circuit. The lights can be distributed over streets and buildings, either in series or in "multiple arc," that is to say, in derived circuits. The completeness of each circuit is a great advantage in the division of the current. Lodighin's light was publicly exhibited in London and Paris, and awarded the Lomonossow prize of the Russian Academy of Sciences. In some recent experiments for the Russian Government, one of these lights placed in a box, with a reflector behind and a lens in front, sent a beam nearly ten miles and lit up objects at that distance very sensibly.

But, for the nonce at least, the so-called "electric candle" of Jablochkoff has cast Lodighin's light into the shade. M. Paul Jablochkoff, a Russian electrician of Paris, patented his plan in this country in 1876. Like Lodighin's plan it obviates all necessity for regulators. Two carbon points may still be employed, but instead of pointing them to each other, he places them side by side, separated by a thin slip or plate of an insulating substance such as porcelain, brick, magnesia, but preferably kaolin or pure clay. A figure in vol. 5, p. 115 of the *Telegraphic Journal*, shews the arrangement of this compound *wick* or "candle." One of the carbons is usually made longer in the point and also stouter than the other. The current is passed along one carbon across the space between the points and down the other. In its passage between the points it forms the luminous arc; but with this peculiarity, that it heats the edge of the kaolin plate till it glows with a soft, white, steady, and brilliant light. The kaolin melts away like wax at the same rate as the carbon wastes down. The "candle" can be placed upright in a candlestick or sconce, and hence its name. The compound wick of carbon and kaolin is employed for the larger lights. For the smaller lights, kaolin alone is sufficient. M. Jablochkoff finds that the intermittent induction current from an induction coil sent by a more conductive material along the edge of a plate of kaolin, yields a luminous band of great splendour from the incandescence of the plate. For rooms and street lights, a piece of prepared kaolin, held in pincers, is a sufficient wick. The rate at which the kaolin fuses away is only about a centimetre in ten hours. A great number of these luminous centres of various sizes and intensity may be maintained from one induction coil without interfering with one another. It is only necessary to have a separate secondary coil for each light. The current can then be turned on and off

* This invention proves to have been forestalled by an English patent of 1845.

with the ease and simplicity of gas. With a magneto-electric machine supplying alternating or intermittent currents, the make and break apparatus of the induction coil may be dispensed with, and the current sent direct through the primary coil. Again, with a machine such as Lontin's, yielding a number of separate intermittent currents, the induction coil itself may be dispensed with as a distributor of the current. MM. Denayrouze and Jablochkoff have, it is said, easily obtained fifty luminous centres in graduated series of power, from one current source, the weakest light giving a glow equal to the flame from one or two gas jets, and the stongest equal to that from fifteen jets.

Jablochkoff's light was exhibited in June of last year at the West India Docks and caused a remarkable wave of decline in the value of gas shares. The experiments were successful and very striking. A large tent covering an area of nearly a thousand square feet was illuminated by four lights set on lamp-posts, and enclosed in globes of opal or ground glass, in order to increase the diffusion of the rays. When the current from a two-and-a-half horse power engine was let on, the light blazed out with almost blinding brightness. Some flashes occurred for a few seconds till the kaolin got properly a-glow, then the light was soft and continuous. At thirty feet from a lamp the faintest pencil lines on paper could be distinguished. The most delicate colours retained their noonday purity of tint, even those of a faint straw shade. When the electric lights were put out and gas-lights substituted, the effect was a sickly yellow hue. A warehouse was also lit up by three naked candles, and a ship lying alongside a wharf with two, to show that lading and unlading operations could be carried on by night.

The success of the Gramme, Siemens, and other magneto-electric machines, and of the wicks of Lodighin and Jablochkoff, have largely contributed to excite the present activity of invention in electric lighting, and to direct public attention to the subject. A number of minor systems, all more or less ingenious, for supplying and distributing the current have recently been devised, and also improvements in the form and preparation of the carbon points, among which we may mention a plan for coating the carbon electrodes with metallic copper which has been approved of in Russia, and Mr. Werdermann's plan for coating them with a substance which will exclude the air, fuse, and produce a good light, such as calcined magnesia, borax, and sulphate of magnesia. Doubtless other valuable methods will be arrived at before long. As it is, the electric light has now reached a most useful phase of its development. Its use is being steadily extended, if not at home, at least abroad, and especially in France, Russia, and Germany. Railway stations, such as those of Lyons and La Chappelle in Paris; large public buildings, as the Louvre and the Opera House, Paris; workshops, wharves, and squares, mills and factories, are being supplied with it. The chief light-houses of nearly all the European maritime nations have been fitted with it; harbour works at Havre has been carried on at night with perfect ease over 300,000 square yards of area by 150 labourers with the light from a number of lamps, each giving a light equivalent to 500 gas jets. It is being employed as a head light for locomotives and ships. The s.s. *Richelieu* of the General Transatlantic Line is fitted with a light equivalent to five hundred Carcel jets—a Carcel jet, or French unit of light being the light obtained from a Carcel burner consuming 42 grammes of pure colza oil per hour, which is about eight times greater than the English unit of light, or the light obtained from a pure spermaceti candle burning sixteen grains per hour. It is set up on a tower on the front part of the ship and illuminates an arc of the horizon of 225°. The light can be controlled from the captain's cabin, without stopping the magneto-electric machine. As a safe-guard against torpedoes the electric light is likely to prove a useful ally. Our own war ships the *Téméraire* and *Alexandra* have been equipped with powerful lights for this purpose. They are placed in a commanding position, one on each side of the bridge, and will light up every portion of a vessel brought under their rays, as well as the surrounding sea for a great distance. They can be directed to any part of the horizon at will, and at once extinguished or lit up.

The cost of the light is considerably less than any other kind. Taking into account the purchase money of the apparatus and fitting up expenses as compared with gas, the saving is about 33 per cent. with the Gramme machine. A Gramme's machine yielding a light equal to 100 Carcel burners, costs about £60. In addition to this there is the motive power to be supplied, either from a steam engine or a hydraulic motor of several horse-power. At the Duncommon Works, Mulhouse, the Gramme light was established at a cost of £400, and is eqivalent to 400 Carcel burners. The cost of establishment for La Chapelle Depôt, Paris, a building 230 feet long by 82 feet wide, lit by two lamps, was £920. The cost of maintaining this light is said to be not more than about eight pence per hour per lamp.

When we consider the economy of the electric light, its great brilliancy, its freedom from the danger of fire or noxious fumes, we cannot doubt that it will make a vigorous headway, and in many cases, will supersede gas and other sources of light. It can be employed in circumstances which exclude the use of ordinary flames, as for instance, in the diving bell and the ill-ventilated mine. A light whose brightness renders us partially independent of the sun, and turns the darkness of midnight into an artificial noon, cannot fail to be useful in a multitude of ways, some of which may not now be foreseen.

RUHMKORFF.

It is our melancholy duty to record the death on the 20th ult., of one of the most world-famed of modern scientific workers.

Heinrich Daniel Ruhmkorff was born at Hanover in the beginning of the present century, the date being variously stated as 1801 and 1803. He appears to have been of humble origin, and to have consequently lacked the advantages of education; little however is known of his early life.

While still a youth he found his way to England, and obtained employment in the factory of the late Mr. Joseph Brahmah, of Pimlico, the inventor of the hydrostatic press bearing his name. In 1819,

Ruhmkorff migrated to Paris where he was fortunate enough to obtain a position, humble though it was, in the laboratory of Professor Charles Chevalier, who at that time was one of the first French physicists. Here he had opportunities of seeing and experimenting with electrical and other scientific apparatus; and thus he became imbued with an earnest love for the branch of science with which is name is now so intimately associated. The ingenuity and aptness for this kind of work displayed by him aroused the interest of M. Chevalier, who, some time after, generously assisted him in setting up in business for himself as a maker of philosophical apparatus. In this business he was naturally successful; for being unfettered with what has aptly been termed "the inertia of the instrument-maker's mind," he at once set out to discard old rule of thumb methods, and to adapt his instruments upon true scientific principles to the work for which they were intended. The friendship of his former employer, and his own efforts to raise the standard of his adopted profession, soon brought him prominently before the men of science of his day, and secured for him a prosperous business.

The first of Ruhmkorff's patents was for a thermo-electric battery, and was taken out in 1844. But his attention was chiefly directed towards the phenomena of electro-magnetic and magneto-electric induction; and it was in this field that he was to reap his great harvest and render his name famous.

It is unnecessary in these columns to do more than refer to the splendid discoveries of the illustrious Faraday in 1831, and the following years, and the subsequent extension of those discoveries by Henry, Sturgeon, Arago, and others. Suffice it to say that, profiting by the results achieved by these physicists, and by the researches of M. Fizeau and others in France, Ruhmkorff succeeded in the year 1850 in rendering magneto-electric induction visible in the form of sparks an eighth of an inch in length. The induction coil with which this was effected was exhibited in 1851, and became at once the *entretien* of scientific Europe.

When Ruhmkorff constructed this first coil, he had, however, not learned how to combat the troublesome "extra-current" due to the induction between the convolutions themselves. He *might* probably have done so in time; but it is only fair to admit that without the "condenser," invented by M. Fizeau, the startling results attained would have remained impossible. The application of the condenser to Ruhmkorff's coils wonderfully enhanced their effect. We must not forget to mention, however, that one of the proximate causes of the success of these coils was the scrupulous attention paid to their insulation.

Numerous modifications and improvements were afterwards made, not only by Ruhmkorff, but also by the English makers, Mr. Hearder, Mr. Bentley, Mr. Ladd, Mr. Apps, and others; but the successive advances made of late years have been rather in growth of dimensions than in any other respect, culminating, for the time being, in the renowned inductorium constructed by Mr. Apps for Mr. W. Spottiswoode, F.R.S., with its secondary wire of 280 miles length, and its 42 in. spark.

With regard to the *cui bono* question, the question of what the general public will probably call the "practical value" of the induction coil, we feel that it would be ungrateful to take the discussion out of the hands of the great breakfast-table organ *The Times*, which is now periodically scientific. Apart from the various appliances of medical electricity, and the itinerant "shockers" of the race-course and country fair, numerous practical applications of the induction coil will suggest themselves to electricians, one of the most recent being the divisibility of the electric light.

Foremost among the numbers who flocked to visit and congratulate Ruhmkorff, was the late lover and munificent patron of science, Mr. J. P. Gassiot, F.R.S.,, who, as is well known, had a decided *penchant* towards this branch of physics, and to whom the world is largely indebted for the perfection of the induction coil, and its employment in the examination of "stratified" discharge in various gases, another of the "practical" uses of the coil.

At the Exhibition of 1855, Ruhmkorff gained a first class medal and the decoration of the Légion d'honneur. In 1856, and the four succeeding years, the Academie des Sciences awarded him the annual Trémont prize of 1,000 francs. In 1858, and again in 1864, he obtained the first prize of 50,000 francs for applications of electricity. He was a member of the Physical Society of France, and a contributor to *Les Mondes*, and various other scientific papers.

At the advanced age of seventy-six (assuming his birth to have been in 1801) M. Ruhmkorff passed away, somewhat suddenly, on the 20th of December. In an address delivered at the grave, M. Jamin referred to him as a man whose life had been spent in the pursuit of science, and whose earnings had been devoted to research and to works of benevolence.

THE TELEPHONE AND ITS APPLICATION TO MILITARY* AND NAVAL PURPOSES.

By W. H. PREECE, Vice-President Soc. T. E. and Member Institution Civil Engineers.

(Continued from page 9.)

WE have now to consider how we can catch up, as it were, these sounds, and convey them into something else. It is said that Lablache could sound a note so deep and loud that he could crack a tumbler. Whenever anyone sings in a room, something can be always heard to rattle. If you open the piano, and sound the vowels on the middle notes, you will hear the piano repeat them. Hence, we learn that the air vibrations can be imparted to other grosser matter in their path. I hold before my mouth this disc of parchment—a small drum-head. It responds to the tones of my voice. I can make this evident to you. It is so constructed that it makes and breaks an electric current every time it vibrates. This electric current operates as an electro-magnet. The electro-magnet actuates an armature. If the motions of this armature are of the same number as the disc, we shall have the note repeated. There you are. Every note I direct upon the disc is repeated by the magnet. But I cannot vary this note. Whether I shout or whether I hum; whether I sound the note upon an instrument or upon a tuning-fork, the note

* Read before the Royal United Service Institution, Dec. 21st.

given out by the magnet is the same. It varies only in pitch, and not in loudness or in clang-tint.

Now I must make a temporary diversion into the realms of electricity.

There are many ways of producing electricity. We have just used a battery where the electricity was produced by chemical decomposition or combustion of zinc, just as heat is produced by the chemical decomposition or combustion of coal. We can produce it by friction or by heat, but one very common mode is to produce it by the motion of a coil of wire in the neighbourhood of a permanent magnet, or *vice versa*, by the motion of a magnet near a coil of wire. This is how an ordinary shocking coil is made. Here is a large permanent magnet and here is a coil of wire. I suddenly move that coil of wire, a current is produced, and I have rung a bell. But even if the magnet be fixed and the coil be fixed, any variation in the strength of the magnetism about that coil will produce a current of electricity in that coil. Thus if in front of that magnet which has a coil fixed on its pole, I move this mass of iron, a current will be produced in that coil. And for every motion of that piece of iron I can produce a current of electricity. But more than that, the current will rise and fall in intensity exactly as the iron moves. Hence the currents of electricity produced in that coil will vary exactly as the motion of that mass of iron. Now suppose that mass of iron to be a thin disc like our parchment drum-head, but of iron; and I speak to that disc. We know that that disc will respond to my voice. Whatever words I sound, however I vary them in pitch and loudness and quality, that disc will vibrate in number, amplitude and form, exactly responsive, and currents of electricity will be produced in that coil which will vary exactly in number, strength, and form, with the words I utter. Let this coil be connected with an exactly similar coil at some distance off, and let the currents in the first coil circulate through the second, then if the second coil surround a mass of soft iron, these currents will induce magnetism in the soft iron, and the strength of this magnetism will vary exactly with the currents producing it. If in front of this iron coil we plant an iron disc exactly like the first one, then every time the iron coil is magnetised it will attract the iron disc, and will cause it to move. Now the motions of this disc will vary exactly with the variation of the magnetism of the coil. The magnetism of the coil will vary exactly with the strength of the currents which will vary exactly with the motions of the first disc, and hence the motions of the second disc will vary exactly with those of the first. In fact, they will be an exact reproduction of the first. Hence with whatever note the first disc vibrates, however much it varies in pitch and loudness and quality, the second disc reproduces those vibrations exactly. Those vibrations are imparted to the air and thus we have sounds reproduced with all the delicate variation of the human voice. The sound of the human voice is transmitted into electric currents, and these currents again produce sonorous vibrations which exactly reproduce the human voice. Indeed, there is no sound which the human lips can produce or the human ear can detect, which cannot be reproduced on the telephone, and where it not for practical difficulties, sounds that "mellow to sadness now madden to crime," could be as easily transmitted from the east to the west as from this hall to the room above. In fact, to "waft a sign from Indus to the Pole," is removed from the poet's dreamland, and has become as much a matter of fact as "extracting sunbeams from cucumbers."

But not yet—the vapourings of imaginative newspaper correspondents are not yet practical. The articulating telephone itself is an extremely delicate apparatus. It is subject to interference by every waif and stray current that wanders into a telegraph wire, and their name is legion. Atmospheric electricity, earth currents and the influence of neighbouring wires will generate these troublesome wanderers and interfere with its action. So that on existing lines of telegraph, except for short distances, it has not yet been found useful or even practical, but on short independent isolated lines like those used for field telegraphs, it is a thorough practical instrument, and well deserving the fullest trial that actual service can give it.

It works to perfection in mines. There it is not only free from all extraneous troubles, but the silence of the grave facilitates the operation of its "still small voice." It is not even necessary in such places to put it to the ear. Wherever, however, extraneous sounds intervene, not only is it necessary to put it close to the ear, but to effectively shut out all disturbing elements, two telephones are used, one to each ear. A bi-aural stethoscope applied to it is also found an useful adjunct. By its means reading is very simple. How far it could be heard amidst the roar of artillery and the din of battle, remains to be tried.

What it does is this: it transmits to a distance far beyond the reach of the ear, or of the eye, the words of command, the tones of voice, the distinct and unmistakable articulation of the general as well as of the private. Such an apparatus must be valuable for military purposes.

How far it can be utilised for naval purposes remains to be seen. Wherever a wire can extend there can the voice be sent. In communicating between the bridge and the wheel, between the turret and the engine-room, between the look-out and the officer of the watch, it ought to be useful. For diving operations it is invaluable. In torpedo operations and range-finding it may prove useful.

But at present it is a mere child. It has startled us all by its novelty, its beauty, and its simplicity. Time alone is required to establish its utility. Probably no instrument that has ever been devised has created more sensation, or has attracted so much attention, and I feel highly honoured in having been allowed to bring before such a distinguished audience the incomparable invention of Alexander Graham Bell.

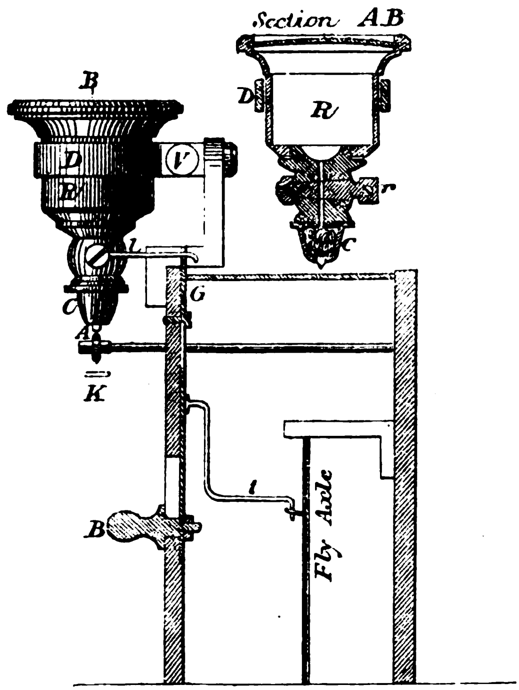
THE SIBERIAN TELEGRAPH LINES.

The *North China Herald* hears of the arrival from Japan of three Danish gentlemen, Captain W. de Hedemann, Mr. Nielsen, telegraph engineer, and Mr. Falck, inspector of telegraphs, who have made the voyage overland from St. Petersburg to Wladivostock. They formed part of a mixed commission, sent out by the Russian Government in conjunction with the Great Northern Telegraph Company, to inspect thoroughly the land lines

through Siberia, and they were accompanied by three high functionaries of the Russian Telegraph Department. To give an idea of the immense task just accomplished, it is interesting to state that the commissioners set out on January 30, 1877, from St. Petersburg, and arrived at Wladivostock on September 17, having travelled 9815 Russian versts; and a 100 Russian versts being equal to 66 3-10ths English statute miles of 1760 yards, the distance from St. Petersburg to Wladivostock is as near as possible 6707 miles. Owing to heavy inundations the commissioners encountered great difficulties on the voyage between Khabarofka and Wladivostock, and had sometimes to travel by boats and sometimes on foot, the roads being impassable on horseback. When the labours of the commissioners are reported at head-quarters, and the proposed ameliorations can be carried out, it is expected the lines through Siberia will be put in a thoroughly efficient state, and the usual interruptions in spring and autumn avoided.

AN IMPROVED INKER FOR MORSE APPARATUS.

SINCE the invention of the inking disc by Mr. Thos. John, in 1856, various arrangements have been devised for furnishing the marker of Morse apparatus



with the ink necessary for the impression of signals. In the system adopted by the Austrian engineer, and in the more recent one of Messrs. Siemens and Halske, the disc has a double movement of oscillation and rotation in a reservoir filled with ink; but the arrangement most generally in use since 1857 is that of Messrs. Baudoin and Digney, in which the marking disc is rubbed tangentially by a roller soaked with an oily ink * * * * * * *

The practical value of any inking method is gauged by the neatness of the impressed signals, the length of the interval between two successive renewals of the ink, and the amount of care required to keep the apparatus in good working order; on these depends the speed at which messages can be taken off.

In this respect the pad (*tampon*) presents faults which the Messrs. Digney have sought to obviate by giving it a to-and-fro movement, and in compelling it to rotate under the action of light supplementary parts.

More recently the same inventors have improved the absorption of the pad by placing above the inking-disc an oscillating reservoir, capped with a compresser, and held below by a throat-piece or tongs.

This arrangement has just been modified by M. Devos, mechanician to the Belgian telegraphs.

* * * * * * * *

The inker of M. Devos is composed of three parts:—A reservoir R, a conduit which can be opened and closed by the stop-cock *r*, and a tank *c*, the bottom of which is pierced with an opening, and in which is placed some bibulous material, wool, sponge, or cotton preferably, to perform the office of the ordinary roller.

This inker is adjusted over the inking-disc in a collar D, which can be tightened by the screw V, and is supported by an angle-piece fixed to the case of the Morse instrument.

The ink from the reservoir is only admitted to the tank while the paper is travelling; the same motion which releases the clockwork opens the stopcock *r*, while the stoppage of the fly closes it.

To this end, the rod *l* rests in a notch in the slide G, movable vertically, and provided with a knob B. From G there is a bent lever *t*, which, when the clockwork is closed, is caught by the fly. On raising the knob B, the train is released and the stopcock *r* is opened, and *vice versâ*. When the supply of ink becomes deficient, it is only necessary to press the dome-shaped spring at the head of the reservoir R. This spring can be caused to resume its shape by placing in the upper part of the ink bottle a ring or perforated plate to limit the depression.

Morse instruments, fitted with M. Devos' inker, have been in use for four months at some of the principal Belgian Telegraph Offices. The staff are unanimous in their opinion of the superiority of this arrangement over the ink-roller. On an average, one charge of ink is sufficient for the reception of 1600 messages, including acknowledgments and repetitions.—*Journal Télégraphique*.

Review.

Traité Elémentaire de la Pile Electrique. Par ALFRED NIAUDET. Paris: Baudry, 15, Rue des Saints Pères.

M. ALFRED NIAUDET, better known in England as Niaudet-Breguet, has written a useful and valuable book on the battery, which, like all French books, is admirably put together and splendidly illustrated. There is an absence in telegraphic

literature of a work specially devoted to the methodical study of batteries in general, and their consideration in text-books and manuals of electricity and telegraphy has led to their description being curtailed and the number described being restricted. M. Niaudet has endeavoured to fill this blank by describing nearly every known form of galvanic battery. Commencing first with single fluid elements, he then proceeds to double fluid elements, and finally considers those which can scarcely be grouped in either of these two marked divisions. He carefully defines all the terms used, and enlarges considerably on that phenomenon called "polarisation," the source of so much trouble in current effects. He completes the work by giving a series of very valuable tables—which will be found very useful to telegraph engineers—showing the resistances of the solids and liquids which are used in the construction of batteries, and the electromotive forces of a great number of combinations, according to the observations of several physicists. He carefully eschews theory, confining himself to facts, and contenting himself with the simple chemical reactions that occur in each element. It is a book intended for the non-scientific and non-mathematical, and one which any intelligent workman or student can read with pleasure and advantage.

The work is confined to a combination of what we call "galvanic" batteries, or what he calls "piles hydro-électriques"; thermo-electric piles, and other machines for the production of currents, are not dealt with. It is curious that Galvani's name, instead of Volta's, should have become associated with this form of instrument, for Volta was certainly its originator; nevertheless, we do speak of a Voltaic cell. There is no accounting for scientific conventions. There is, however, a chapter on dry piles, gas batteries, and secondary batteries, the last being extremely full and interesting.

We should have liked to have seen every battery treated in the same way, its chemical reactions given in proper formulæ, its electro-motive force indicated, either in volts or with reference to some standard, and its internal resistance given in ohms. A table containing this information would be most valuable. Perhaps in a new edition M. Niaudet will supply this deficiency.

He concludes with a description of a new battery, recently experimented upon by M. Jablochkoff, in which currents are obtained directly from the combustion of carbon. The liquid of this element is nitrate of potash or of soda, one plate is carbon the other platinum or lead. The carbon combines with the oxygen of the nitrate, producing torrents of carbonic acid gas, the lead remains unattacked. The nitrate is melted at first, but when once the action commences, it remains melted from the great heat generated. This battery has not yet assumed a practical form, but it is the first glimpse of a wide field of research. If the combustion of coal can be directly converted into electricity, electromagnetic engines will become economical and useful.

We hope to issue with the number of the 1st prox., a permanent photograph of Dr. Siemens, which has been specially taken for this journal.

Proceedings of Societies.

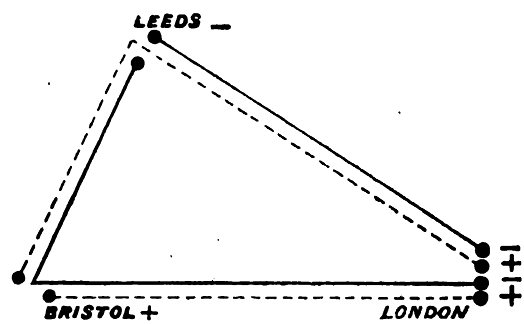
SOCIETY OF TELEGRAPH ENGINEERS.

At the meeting of this Society, held at Great George Street, on the 12th ult., Professor Abel, C.B., F.R.S., in the chair, a paper was read by Mr. A. J. S. Adams, of the Postal Telegraph Service on "Earth currents on land lines," in which the author gave the results of several years' observations.

The subject is one of considerable experimental difficulty and trouble, owing to the contradictory nature of the results often obtained; these conflicting results being usually referable to defective insulation on the line, which permits leakage from wire to wire and also from earth to wire at various points. From this cause it sometimes happens that a wire which gives a positive current when the distant end is to earth, gives a negative when disconnected.

Generally speaking, earth currents are weak, and vary slightly but continually in strength, but are often constant for hours in direction. Occasionally, however, they are very irregular and unsteady; and in rare occasions, exceptionally powerful currents are met with. These have been very few of late years.

It is found that earth currents of some sort and strength are *always* present in all lines and in all weathers, very short lines only excepted. It has been



noticed that, as a rule, the clearer the atmosphere and the less cloudy the sky, the stronger are the earth currents.

If a line be *perfectly* insulated the current observed when the distant end is to earth disappears when that end is disconnected. In practice, of course, this rarely happens, and the only effect of disconnecting is to augment or diminish the normal current, such change being in fact the resultant effect of polarisation at the various points of support. This local polarisation may partially or entirely mask the normal earth current, so that it sometimes occurs that the currents received from two or more parallel wires starting from the same place differ both in magnitude and in direction.

The accompanying diagram was adduced to show that the earth current is conducted directly by the wire, and is unaffected by the electrical condition of the atmosphere or earth at places *en route*. Two wires are shown, extending *directly* from London to Leeds and Bristol respectively, and two others to the same places *indirectly*, viz., one to Leeds *viâ* Bristol, the other to Bristol *viâ* Leeds. It will be seen that although Leeds and Bristol were electrified oppositely, relatively to London, the currents received from each pair of wires from the same place possessed the same sign.

Much of Mr. Adams' labours has been devoted to an attempt to establish *laws* of daily maxima and minima, and the direction of the line of annual maximum

intensity. No very great success in this respect is claimed by the author at present, the subject being one of great complexity and trouble. The state of business usually allows of observations being taken only between the hours of midnight and 6 a.m. Whole nights' observations have frequently been rendered useless by the conflicting disturbances already referred to, as also by abnormal disturbances or *storms*.

A large number of admirable charts, diagrams, and tables were exhibited, summing up the results of observations during the years 1873 to 1876. These appeared to show that there appears to be daily maxima from 10 a.m. to 11 a.m., from 4 p.m. to 5 p.m., and from 1 a.m. to 2 a.m., with a minimum at or about sunrise. They further show that the line of maximum intensity lies somewhere between N.NE. and E.NE. on the one hand, and S.SW. and W.SW. on the other.

Careful observations had also been made to identify, if possible, earth-current phenomena with those of wind, clouds, tides, dew-point, &c., but no apparent connection had been traced.

A short discussion followed the reading of the paper.

A second paper by the same author was read, entitled "Sonorous properties of electro-static induction."

It had been found that on attaching a circular plate of iron to the bar magnet of a telephone, and connecting the secondary wire of an induction coil to this plate and the vibrating diaphragm respectively, thus discarding the helix, that tone-vibrations transmitted through the primary were reproduced by the plate and membrane. Such tones considerably intensified by the addition of a second magnet and plate, as shown in fig. 1. It was necessary to keep the whole arrangement well insulated; exposure to damp for a few hours entirely stopped the reproduction of sound.

The more nearly the magnetic plates were approached to the diaphragm, the louder the sounds, so long at least as the insulation remained perfect.

It was observed that when the human body was placed in the circuit, the tones were reproduced only so long as the currents passed *unfelt*, but ceased directly shocks became sensible.

The tones emitted by this "inductophone," as it was termed by Mr. Adams, were feeble while the magnets were unconnected; but on connecting them by an iron strap, or even by a wire, as shown in the figure, the plates being separated from the diaphragm only by paraffined tissue paper, they were much intensified, and could be heard distinctly at a distance of several yards.

Further experiments showed that similar results were obtained when sheets of tinfoil, copper, brass, &c. were substituted for the magnetic plates and diaphragm; in fact, the phenomena appeared to be neither more nor less than effects of static charge and discharge, as in the Varley telephone, although this view was not ultimately adopted by the author.

In subsequent experiments one end of a coil of fine wire wound on an iron core was connected to one end of the secondary, the other ends being respectively left free (fig. 2). Tones now sent through the primary were audibly reproduced from the coil.—(? Page's experiment.)

Upon connecting the plates of the inductophone to one end of the secondary coil, leaving the diaphragm free, the tones were still produced. In this case it was found necessary always to connect the plates to one particular end of the secondary coil. (The author did not state *which* end was necessary relatively to the primary current.)

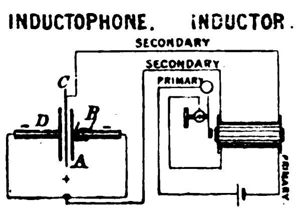


Fig. 1.

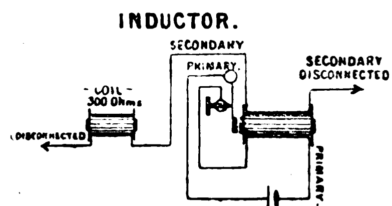


Fig. 2.

Batteries of from 80 to 500 Daniell's cells were connected to the plates and diaphragm, through a Wheatstone transmitter, and the tones emitted at the transmitter were reproduced by the inductophone; but they were in all cases feebler than with the intervention of an induction coil and one bichromate cell.

A brief discussion, in which Mr. J. Laister and Mr. W. H. Preece took part, followed the reading of this paper; and a cordial vote of thanks was accorded to Mr. Adams for his interesting communications.

Notes.

A SMALL work on the "Telephone," by Professor A. E. Dolbear, of Tufts College, Mass., has appeared in America. The author asserts himself to be the inventor of the speaking telephone in which magneto-electric currents are utilised for the transmission of speech and other kinds of sounds. Some months ago an assertion of the same kind was made by Mr. John Cammack, an Englishman, and drawings were furnished of a telephone designed by him in 1865, and which "want of means" had prevented him from working out. Mr. Cammack's drawings showed his telephone to be similar to Bell's in form and identical in principle. None of these prior-invention statements are satisfactorily supported.

A TELEPHONE CALL.—Mr. W. C. Röntgen, writing in *Nature*, describes an ingenious method of obviating the use of a call-bell and battery for the purpose of attracting the attention of the person with whom it is desired to speak by telephone. The principle of the novel call consists in transmitting the sound of a tuning-fork by the telephone and making it set another tuning-fork, in unison with the first, into audible vibration at the distant end of the line. In order to carry out this principle a coil is fitted to each pole of the telephone

magnet, and these coils are both connected in circuit with the line. One is for the voice, the other is for the call-fork. The arrangement at both ends of the line is similar, and the two forks are in unison. When the sender draws a fiddle bow over his fork the note given out is transmitted by telephone to the receiving end of the line, where it is taken up by the call-fork, which yields an audible note. Mr. Röntgen tried the arrangement in a hall with one hundred people present, and all could hear the fork sounds. A König Ut_4 fork giving 12,000 double vibrations per second was heard, thus showing that reciprocal variations of magnetic force can occur even when the forces producing them vary 24,000 times a second.

ON Friday, February 1st, the evening discourse at the Royal Institution will be delivered by Mr. W. H. Preece on the "Telephone."

THE aid of the telephone is being secured in Jersey City in connection with the Courts. A telegraph wire is being laid from the Hudson County Court House to the telegraph office in Montgomery Street, and a telephone will be attached to each end, whereby lawyers can communicate with each other rapidly between their offices and the Court-house.—*The Operator* (America).

TELEPHONES are rented in the United States by the Telephone Company at 50 dols. a year for a set of four, two at each end of the line. If the line has to be put up, an extra charge is made, depending on the length of the line.

THE most notable of recent trials of the telephone is that on the Dublin to Holyhead Cable, a distance of sixty-seven miles. Speaking could be carried on with very little diminution of distinctness.

THE Bureau Internationale has published a second edition of its map of telegraph lines. The area comprised in it extends from the Equator to the sixtieth parallel of north latitude, and from longitude 20° west to longitude 90° east from Greenwich. The principal map, which is in the form of a planisphere showing the main lines of telegraph in the world, is supplemented by smaller plates, giving on a larger scale some systems too complicated to be clearly shown upon it. The price of this second edition is only 2·50 francs.

THE Western Union Telegraph Company of the United States has concluded a lease of the telegraph lines owned and operated by the Central Pacific Railroad Company, west of Salt Lake and throughout California, for a term of five years and thereafter until one year's notice by either party shall have been given for its termination. This agreement consolidates all the telegraph interests on the Pacific Coast under one management.

FAST TELEGRAPHING.—President Hayes' message to Congress on December 3rd last contained 13,000 words, and was sent from Washington to New York over ten wires in forty-four minutes. The message was copied on manifold paper, each receiving clerk, of which there were ten, taking eight copies.

MESSRS. GERRIT SMITH AND G. A. HAMILTON, the American electricians who recently introduced the quadruplex system into the English postal telegraph service, have returned safely to New York. They express themselves very much gratified, not only at the success of their mission to this country, but also at the cordial reception given and the kindness shown to them here; and they attribute not a little of their success in introducing quadruplex, to the intelligence and skill of the clerks who manipulated the instruments. Messrs. Smith and Hamilton appear to be favourites with their friends, for a special excursion was got up in their honour to welcome them home.

THE *Cologne Gazette* denies that there is any telephone in use on the line between Prince Bismarck's house at Varzin and the Chancellor's office at Berlin. The distance is stated to be 363 kilometres, and this the *Gazette* says is too great for such a purpose; but 363 kilometres are only about 225 miles, and we know that the telephone has been used over a line 250 miles long.

IN Keelmay's electric log an electric circuit is applied to the ordinary patent log, so that a revolution of the waves will, by a make and break arrangement, actuate an indicator in the captain's cabin. The number of knots run can be read off the indicator, and hauling in of the log itself is not required. A similar arrangement, we believe, was invented some years ago by Dr. Siemens.

CHEMICAL EFFECTS OF THE ELECTRIC DISCHARGE IN GASES.—M. Berthollet finds that both the positive and negative discharge in oxygen form ozone, more being formed, as a rule, at the positive electrode. In a mixture of nitrogen and hydrogen, whether moist or dry, the discharge from a Holtz machine did not produce the slightest trace of nitrogen compounds; traces were, however, observed with discharges from a Ruhmkorff coil, but only at the highest available tensions. When the vapour of organic compounds was enclosed along with nitrogen in tubes containing a metal electrode electrified by a Holtz machine, acetyline was produced in notable quantities. The absorption of nitrogen by organic compounds is effected equally well by both positive and negative discharges, and at low as well as high tensions, although more time is required for the process with low than with high tensions. With these nitrogen compounds no traces of ammonia, nitric, or nitrous acids, or hydrocyanic acid, appear to be formed. M. Berthollet has also produced absorption of nitrogen by organic compounds with the current from an ordinary voltaic battery.

A CONSTANT single fluid battery in which the plates are kept free from liberated gas by being revolved on a shaft, has been patented in America by Mr. C. A. Hussy.

IN a recent paper to the Royal Asiatic Society of Bengal, Mr. R. S. Brough remarked that the strongest current which at any moment works the Bell telephone does not exceed $\frac{1}{1000000000}$ of the centimetre gramme second unit current. The current with which Indian relays are worked is 400,000 times that strength.

ELECTRIC ENGRAVING ON GLASS.—A short time ago, M. Gaston Planté, in causing a powerful electric current to enter a voltameter by means of a platinum electrode in a glass tube, observed that the glass was deeply corroded by the discharge. Following up this discovery, M. Planté has now communicated to the French Academy of Sciences a process of engraving on glass and crystal by means of electricity. The process consists in covering the plate to be engraved with a concentrated solution of nitrate of potash, put in connection with one of the poles of the battery, and in tracing out the design with a fine platinum point connected to the other pole. The results are said to be of marvellous delicacy. The battery employed by M. Planté was composed of fifty or sixty secondary elements. Round articles can be engraved by adding gum to the solution to make it adhere.

TELEGRAPHING WITHOUT WIRES. — Professor Loomis, the distinguished American astronomer, has recently succeeded in telegraphing by means of aërial electric currents without the use of a wire to complete the circuit. The experiments were made between two lofty peaks, ten miles apart, in the mountains of West Virginia. He flew two kites, one on each peak, by means of copper wire instead of the ordinary pack-thread, and signals were transmitted between the kites by making and breaking the earth connection. Continuous aërial currents were observed, except when the weather was violently broken. It is said that a scheme is mooted by Prof. Loomis for testing this method of telegraphing between the Alps and the Rocky Mountains! We dare not speculate on the results of such a feat should it be possible to achieve it.

LEMASSON'S LIGHTNING GUARD, described in the *Journal Telegraphique*, vol. ii., p. 601, is, we observe, an anticipation of the concentric grooved cylinders which form part of Jamieson's form of Protector. A metal barrel, grooved longitudinally, is enclosed in a hollow metal cylinder grooved circumferentially, so that the two sets of grooves cross each other at right angles, and cause the cylinder and barrel to present a series of points to each other. The cylinder is connected to the line, and the barrel to the earth, and excessive earth currents on the line can discharge across to earth. Provision is made for exhausting the air from the space between the points, so as to produce a partial vacuum, and facilitate discharge. In Jamieson's protector there are no means of effecting this rarefaction; but the ordinary platinum-wire arresters are applied in addition to the points.

THE GRAMME MACHINE has recently been tried at the Palais de l'Industrie, Paris. A space of 12,000 square metres in area was brilliantly illuminated by two electric lustres, each of six lamps, and placed twenty-seven feet above the ground. The machines were driven by two steam engines of 25-horse power each. It is estimated that 300,000 candles would be required to give the same lighting power.

PLAIN AND GALVANISED IRON WIRE.—In reply to a communication addressed to them by Mr. G. B. Prescott, the well-known American electrician, a number of the European telegraph administrations have, without exception, given the result of their experience as in favour of galvanised wire on the score of ultimate economy. It appears from these reports that the duration of non-galvanised wire for telegraphic purposes in Europe is from 15 to 20 years. Galvanised wire that has been in use some 25 years gives little sign of deterioration.

CHLORIDE OF SILVER CELLS FOR TESTING PURPOSES.—We understand that Dr. Muirhead was the first to observe the remarkable constancy of these cells in testing cables. We have seen a set of twenty, which have been employed every day for the last three months, give a perfectly steady light-spot on the scale during a cable-test. Nor did shaking the battery in the least affect the spot, which proves the suitability of the cell for testing at sea. The battery in question was composed of twenty cells, and was fitted into a portable box about nine inches long by six wide and six deep. This battery can be obtained, we believe, of Messrs. Latimer, Clark, Muirhead & Co. for the small sum of two shillings per cell.

TELEPHONE.—CURIOUS DISCOVERY.—At a meeting of the Royal Society of Edinburgh, on January 7th, Professor Tait announced, on behalf of Mr. James Blyth, M.A., a very curious discovery in connection with the telephone. Mr. Blyth finds that sounds will still be received by a telephone in which the iron disc has been removed, and a disc of copper, wood, paper, or india-rubber substituted for it. The sounds received when such discs are used are much feebler than those obtained by the ordinary telephone. The transmitting telephone may also have a disc of non-conducting material substituted for its iron plate, but in this case it is necessary to use an ordinary telephone at the receiving end. No sound has been detected when no disc whatever is used. The action of the copper disc is intelligible on the supposition that attraction takes

place between the currents in the coil and those which they induce in the disc. Mr. Blyth finds that when the magnet is entirely removed the sound given by a copper disc is not much weakened—a result which supports this view. The india-rubber discs are quite soft, and are not stretched in any way, but simply laid loosely over the pole of the magnet and then pressed against the ear. After the meeting several of the fellows had an opportunity of verifying Mr. Blyth's extraordinary results.

TRAFFIC RECEIPTS.

1877.	Anglo-American Co.	Brazilian Sub. Co.	Cuba Sub. Co.	Direct Spanish Co.	Direct U.S. Co.	Eastern Co.	Eastern Ex. Co.	Gt. Northern Co.	Indo-Euro. Co.	Mediterranean Ex. Co.	Submarine Co.	West Coast America Co.	Western and Brazilian Co.	West India Co.
	£	£	£	£	£	£	£	£	£	£	£	£	£	£
JAN. ...	37,780	11,469	2,311	983	13,530	42,580	24,147	12,663	... ...	... ...	9,668	2,533*b*	10,342	4,058
FEB. ...	32,330	11,606	2,214	784	15,520	35,050	19,645	12,800	... ...	... ...	8,624	2,980*c*	11,343	3,870
MARCH ...	18,880	11,258	3,025	913	8,110	35,491	22,886	16,115	... ...	... ...	9,915	3,128*d*	13,872	5,854
APRIL ...	18,980	11,539	4,706	1,011	6,930	39,861	23,068	16,151	... ...	... ...	11,324	2,362*e*	10,295	7,729
MAY ...	45,420	12,251	4,109	997	17,370	46,309	25,445	18,427	... ...	... ...	11,048	2,170*f*	10,534	7,508
JUNE ...	40,040	9,712	3,295	887	15,260	45,477	24,126	19,663	... ...	... ...	9,960	{ 4,025*g* 2,225*h* }	10,522	5,541
JULY ...	38,790	9,226	2,959	834	14,820	42,713	22,224	19,187	... ...	... ...	9,943	1,925	7,883	4,980
AUGUST ...	41,170	9,407	2,728	804	15,700	40,428	25,371	17,998	... ...	... ...	9,683	2,025	7,790	4,201
SEPT. ...	43,230	9,253	2,466	836	15,940	35,440	22,113	18,445	... ...	... ...	10,029	1,625	9,504	3,802
OCT. ...	49,510	11,260	2,933	945	13,486	37,402	21,388	21,210	... ...	... ...	10,823	2,225	10,037	*5,647
NOV. ...	47,890	12,096	*2,700	918	12,920	38,439	20,794	18,206	... ...	... ...	9,817	1,800	10,368	*4,342
DEC. ...	45,570	12,180	*2,600	885	12,930	37,777	23,980	15,511	... ...	... ...	8,754	1,850	12,882	*4,478

* Estimated. *b*, four weeks ending 13th January. *c*, four weeks ending 13th February. *d*, four weeks ending 10th March. *e*, four weeks ending 7th April. *f*, four weeks ending 5th May. *g*, four weeks ending 2nd June. *h*, four weeks ending 30th June.

Patents.

4418. "Improvements in telephony and telephonic apparatus for transmitting or causing sound by means of the electric current or currents for the purpose of conveying messages and and other useful purposes."—T. WIESSENDOMGER, Nov. 25.

4432. "Improvements in the production and application of electrical currents for lighting and other purposes, and in apparatus employed therefore.—I. RAPIEFF, Nov. 24.

4435. "Electrical apparatus for lighting and other purposes."—S. A. VARLEY, Nov. 24.

4464. "Dynan's electrical machines."—L. SIMON (communicated by S. Schuchert), Nov. 27.

4468. Apparatus for the electrical transmission of telephonic communications."—L. M. de BEJAR T. O'LAWLOR, Nov. 27.

4500. "Electric piles applicable to medical, telegraphic and other purposes."—G. A. SCHOTH, Nov. 29.

4527. "An improved medical electrical appliance."—E. SNOW, Nov. 30.

4557. "Improvements in the methods or process for lighting gas lamps or burners by electricity, and in apparatus employed therefore."—A. VOISIN, Dec. 1.

4608. "Apparatus for taking up, sending, and repeating voice sounds by electricity to and from distant stations or places."—M. T. SALE, Dec. 5.

4685. "Telephones."—C. W. SIEMENS (communicated by E. W. Siemens), Dec. 10.

4706. "An improved voltaic medicated plaister."—W. R. LAKE (communicated by W. D. Potter), Dec. 11.

4748. "Magneto-electric machines."—W. R. LAKE (communicated by E. Weston), Dec. 14.

4803. "An improvement applicable to galvanic batteries."—M. F. ROBERTS, Dec. 17.

4824. "Improvements in insulating telegraph wires, and in preparing insulated subterraneous and subaqueous telegraph cables."—B. HUNT (communicated by D. Brooks), Dec. 19.

4847. "Telephonic apparatus."—C. A. ECEVOY, Dec. 20.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—During the summer of 1876 I observed that the first signs of disease in the potato haulm presented themselves after atmospherical electric disturbances, and surmising that the germs of the disease might be developed under their influence I determined to try the experiment of placing a number of iron rods among the crop of the following season (1877).

Accordingly I placed a number of galvanised telegraph wire rods, No. 6, 4 feet long, which I had pointed before galvanising, 1 foot in the ground and 3 feet above ground, point upwards, at distances of 10 feet, in a small potato field. This was in June, 1877, and after the first signs of disease had already presented themselves after a thunder-storm.

Whilst the disease made rapid progress in the neighbouring potato fields, I observed that the haulms in my field, treated as above stated, showed no signs of progress in the disease.

When I had the potatoes taken up, rather early on account of the wet season, there were a small number of diseased potatoes found among them, and these were picked out and the crop stored in a cellar.

The crop has since remained perfectly sound, and I now enjoy the luxury of as fine potatoes as can be placed on the table.

I write this that others may try my experiment next season, and not only on potatoes but also among other plants which are subject to similar mysterious diseases, such as the hop, the vine, &c., &c.

Newspapers and publications, whose more direct object is agriculture, may give more publicity to the above in the quarter interested in the matter.

I am, Sir,

Yours obediently,

JOSEPH OPPENHEIMER.

52, Brown Street,

Manchester, *Jan. 9th*, 1878.

COL. B.—The address is 157, Great Portland Street, London, W.

General Science Columns.

MINUTES OF PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS, SESSION 1876-77. PART I.—The first volume of the four published last year by the Institution, contains three of the papers which were read and discussed at the meetings. The lighting of the Japan coast, which forms the subject of the first paper, is an extensive work, as the coast line to be dealt with is over 1,500 miles in length. Thirty-four light-houses and two light-ships have been already established. The light-houses were built of stone, brick, iron, or wood, as appeared most suitable. Two of the lights are flashing lights, three revolving, and the rest fixed. Reflector lights were put up in the light-houses first built, but subsequently the dioptric apparatus was adopted as being easier to keep in order, and consuming less oil; the oil now used is mineral oil. The chief peculiarity in connection with these light-houses is, that injury from earthquakes is more to be apprehended than injury from storms. To provide somewhat against the effects of shocks, Messrs. Dad J. Stevenson, designed an aseismatic joint for the table bearing the lights to move on, when the lower portion of the structure might be disturbed. They hoped by thus making a break in the continuity of the parts, to prevent the effects of a shock on the lower part of the light-house being fully communicated to the lights. It was found in practice, that the movable table made the cleaning of the lamps difficult, as it rocked under the weight of the man who cleaned them. The tables were accordingly screwed down, and the only shock which has occurred since the erection of the light-houses, threw over all the lamp glasses and disarranged the working, and an opportunity was lost of testing the efficacy of the aseismatic joint.

The second paper treats of the fracture of railway tires, a very important subject, as it is the cause of many of the unpreventable railway accidents. Imperfect welds, bad materials, and diminution of section at rivet and screw holes, are frequent causes of fractures; but many fractures occur which cannot be thus accounted for. Frost is popularly supposed to cause fractures, but except that the roads become more rigid when the ground is frozen, there appears to be no ground for this supposition, as experiments indicate that there is no material increase in the brittleness of iron with a lowering of temperature. It is suggested in the paper, that the principal cause of failure is due to the constant hammering of the outer surface of the tires affecting the molecular constitution of the metal, causing the outer surface to tend to expand and the inner surface to contract, which produces a considerable strain of compression on the outer and of tension on the inner surface. This view appears to be borne out by the fact that tramway plates exposed to constant traffic, assumes by degrees, a convex form on their upper surface, and become arched underneath. It is curious to note that on this theory, the tires of wheels to which breaks are applied, ought to last longer than other tires, as the outer surface on which there is the greatest strain, is gradually worn away, thus somewhat restoring the molecular equilibrium.

The question of the water bearing capacity of the chalk strata, which forms the subject of the third paper, is peculiarly interesting at the present time, when it is being proposed to get a larger supply of water for London from these strata. The water line in the chalk was obtained by measurements at different wells, and the conclusion drawn from numerous observations was, that the large range of the oscillation in the height of the water line, showed that the water to be obtained from the chalk was limited in amount. No more water can be got out of the chalk than the rain fall on the basin, minus that which escapes by evaporation and is discharged from rivers and springs; but there is no doubt that the chalk strata, which extend over a large area, form excellent reservoirs,

and that the chalk absorbing the rain readily into its pores, causes the loss from evaporation to be comparatively small. Considerable divergence of opinion still exists as to the amount of water that can be obtained from these sources, and more accurate information is needed before any attempt is made to draw a large additional supply of water from them.

Amongst the selected papers, published in the volume, but not read at the meetings, is one by Professor Gaudard, of Lausanne, which deals very fully with the strains to which swing bridges of different types are subjected, and forms a valuable addition to the theoretical part of the subject.

At the end of the volume there are several abstracts, which give brief sketches of the most valuable articles appearing in foreign engineering publications, so that anyone may easily see what has been written upon engineering subjects abroad, and readily find out whether the original articles are likely to contain matter of value for any special reference or investigation. This addition was first commenced in 1875, and though not strictly belonging to the minutes of proceedings, it greatly enhances the value of the publication as a book of reference on any subject relating to engineering.

ENGINEERING IN 1877.—The past year has not generally been a prosperous one for engineers. The general state of distrust on the part of capitalists, induced by the collapse of so many joint-stock undertakings, and the depressed state of trade in almost all its branches, has prevented to a great extent the development of private enterprise during the past year, the effects of which have been felt more perhaps by members of the engineering profession than by any other class. At the same time the uncertainty which has hung over the political horizon of Europe, in consequence of the Russo-Turkish war, has had the effect of checking very much the progress of public works on the Continent. In consequence of this general cessation of works, the manufacturing trades connected with engineering have also greatly suffered from want of demand for their goods, and amongst these the iron manufacturers have felt the depression most severely. In consequence of the improved process of steel manufacture, and the cheapness with which steel rails can now be produced for railway purposes, the iron rail manufacture in South Wales has practically become defunct, and some works employed in that branch of the trade have been recently closed. One of the most important questions that has been engaging the attention of railway engineers is that of continuous brakes. The adoption of some more powerful brake than that in ordinary use has become a necessity for the safety of travelling, and it has been enforced on the railway companies by the Board of Trade during the past year. Several kinds of brake are in use on different lines, but at present none of the principal railway companies have so far committed themselves as to adopt any one kind throughout their entire passenger rolling stock. The past year has not been conspicuous for any great extension of open railways. Two sections have been opened in India, namely, from Jalpaiguri to Atrai, on the Northern Bengal Railway, 134⅛ miles in length, on the 20th August, and the Rangoon and Irawaddi Railway on the 1st May last. The necessities of the Russian armies have led to the construction of some extensions for military purposes in Bulgaria, which, after the war, will doubtless serve for commercial purposes. The Woosung Railway, in China, has been purchased by the Celestial Government, and its traffic stopped; time only can prove whether it will ultimately be dismantled, or reopened and ultimately extended. The Japanese, on the other hand, are themselves constructing railways in their land. A system has been laid out of main lines throughout the island, a section of which, starting from Osaka, is already open. The most important line in progress in this country is the Mansion House section of the Metropolitan Railway, the opening of which will complete the inner circle of that system. An important section of railway was opened last November in Portugal, being an extension of the Northern Railway to Oporto, 2½ miles in length, which passes through a precipitous and difficult country, the most important work on which is the Douro Viaduct, spanning the river of that name, which has an arch of 525 feet span, and is the largest arched span in the world. On the 31st October last, the Thames Steam Ferry was opened with the view of reducing the traffic of London Bridge. Its necessity was fully proved by the amount of traffic attracted to it; but after being open for a little more than a month, its further use was temporarily suspended, owing to an accident which it will require some time to repair, but which was happily unattended by any serious consequences. On the river Severn two important works are in progress, namely, the Severn Bridge, to connect the Great Western and Severn and Wye railways with the Midland, which is only a little less than three-quarters of a mile in length; and the Severn Tunnel, which is being constructed by the Great Western Railway Company to connect their system at Bristol with that in South Wales. The river here is two and a quarter miles wide, and the heading is now nearly half way across. An important new dock was opened at Bristol in February last, which had been completed at a cost of about half a million sterling. It is situated at the mouth of the river Avon, and has a water area of 16 acres. At the same time, at Portishead, another dock is in course of construction, which it is expected will be completed during the current year. Its dimensions are 1,800 feet in length, and 500 feet in width, and together with lock and timber-ponds, it covers an area of 40 acres. Connected with it is a pier of about 1,000 feet in length, for accommodation of passengers by steam vessels. There are also in progress the Victoria Docks Extension Works on the Thames. The

length of the new dock is about one and three-quarter miles, and the width at bottom 500 feet. On its completion—which it is expected will take place next year—the Victoria Dock Company will have a total length of about six miles of quay. At Chatham also extensive extension works are in progress, which will render this the most important dockyard in the world. The extension consists of three large basins, having a combined area of 74 acres, and four large graving docks. These works have already been in hand some years, and they are not expected to be completed within four or five more years.

Although no new ships have been laid down, much has been done to increase the strength of the navy during the past year. Putting the *Inflexible* on one side for the present, we notice the *Thunderer* has been recently pronounced ready for service; the trial trip of this vessel, which was arrested by the bursting of one of its boilers on the 14th July, 1876, was made on the 4th January last (1877). In addition to two pairs of main engines for driving the propeller, the *Thunderer* has besides 26 other engines, in addition to her hydraulic gun gear. During her trial the general mean speed was 13·479 knots per hour. The *Dreadnought*, which was completed almost the same time as the *Thunderer*, made her official six hours' trip on the 19th January, on which occasion her engines developed a power of 8,216 horses. Besides these the *Alexandra* and the *Téméraire* have been added to the navy during the year. The former of these vessels is considered the finest ship in the navy; the latter is remarkable on account of her *barbetté* batteries. Some of the most interesting experiments of the year were made with the guns of this vessel, which were worked on the Moncrieff system by hydraulic machinery. The only additions to the fleet besides, during the past year, consist of unarmoured vessels, the most important of which is the *Euryaelus*, launched at Chatham Dockyard in January. The corvette *Garnet*, smaller than the *Euryaelus*, was also launched at the same dockyard. The *Pelican*, a composite sloop of 1,124 tons, was launched at Plymouth during the year. In addition to these there have also been a few small vessels and gunboats added to the navy in 1877. One of the most remarkable recent additions is the *Lightning* torpedo vessel. She is only 84 feet long, by 10 feet 10 inches broad, and has attained a speed of 19·4 knots an hour. Considerable progress has been made in the use of torpedoes as an integral part of the armament of a man of war, and a college has been opened at Portsmouth for instruction in the use of this weapon. Not much progress has been made in gunnery beyond experiments with the 80 ton gun. The forts at Spithead have at last received their armaments.

The shipbuilding industry on the Clyde has suffered in common with other branches of enterprise during the past year. The amount of shipping launched was the lowest recorded during the last ten years, having been 228 vessels of an aggregate of about 168,000 tons. The largest vessel launched was the *Medway*, of 3,500 tons, and 600 horse-power nominal, built by Messrs. John Elder and Co., for the Royal (West India) Mail Company, besides which there were only five other vessels of over 2,800 tons. Of all the vessels built 104 were screw steamers of an aggregate of 73,000 tons; of paddle steamers there were only 10, aggregating 6,560 tons and of sailing vessels 57, aggregating 75,200 tons. Only two war vessels were turned out on the Clyde last year, namely, the *Firefly* and the *Firebrand*, each of 400 tons and 350 horse-power. An important step in advance has recently been made by the investigation, by a committee appointed by Lloyds' Register of British and Foreign Shipping, of the question of the use of steel for shipbuilding purposes in lieu of iron; considering the superiority of the former metal it is highly desirable that it should take its place for shipbuilding purposes as it has already done in other branches of commerce, and nothing, probably, will conduce more to this end than its recognition by Lloyds' as a proper material for shipbuilding. The question of the use of electric illumination for light-houses has recently engaged the attention of the Trinity Board, to whom reports on experiments, undertaken at their request, has recently been addressed by Professor Tyndall, and Mr. J. N. Douglass. These experiments were carried on at the South Foreland, and lasted over a month, and for them the machines of Holmes, Gramme, and Siemens, were employed. It is not necessary here to record the details of these experiments, but the result has been that the Trinity Board have entrusted to Messrs. Siemens Brothers, the construction of the electrical apparatus for the light-house on the Lizard promontory. The introduction of the telephone during the year must be noticed, but it has so recently been described that further reference to it on the present occasion is unnecessary.

Turning again to India, we have to mention the Madras Harbour Works. These consist of piers projecting from the shore at right angles, 1000 yards apart, for a distance of 830 yards, at which point they turn inwards and approach to within 150 yards of each other, which space is left open for the entrance. These piers will enclose an area of 170 acres. The construction consists of a rubble base, surmounted by a double row of concrete blocks placed side by side, and raised in tiers to a height of 3 feet 3 inches above high watermark. The north pier has already been projected out for some distance, but during the past season some difficulty has been experienced in setting the concrete blocks in consequence of the accumulation of sand on the top of the rubble base. The progress of block setting during the past year has not therefore been so great as had been anticipated. The recent famine in Madras and Bombay has caused considerable activity in the construction of communications and works of irrigation, and the question as to which class of works is the more important with the view of averting famines for the future, or of mitigating their effects, is one regard-

ing which a difference of opinion exists, Sir Arthur Cotton and his adherents being in favour of irrigation coupled with water communications wherever they can be constructed, whilst others advocate a limited extention of well selected irrigation works, together with a further development of the existing railway systems. We shall consider these subjects in detail on some future occasion. The alleged coincidence of maximum sun spot periods with years of greatest climatic disturbances, in cycles of eleven years, is now engaging the attention of Government; and it is understood that General Stractey, who has recently proceeded to India, has been instructed to investigate the evidences bearing upon this subject.

Sewage in the Thames.—Since the opening of the main drainage outfalls at Barking and Crossness, in 1863-4, it has from time to time been asserted that the effect of discharging the sewage of London below Woolwich, instead of above London Bridge, has been to cause an accumulation of sewage above and below the outfalls, and simply to remove the nuisance, formerly experienced between Westminster and London Bridge, to a lower part of the river. Last February, during a discussion at the Institution of Civil Engineers of a paper on "The Sewage Question," Mr. Abernethy maintained that a considerable deposit had been caused by the discharge of the sewage into the Thames. Sir Joseph Bazalgette, who designed the main drainage works, naturally dissented from this opinion, and brought forward figures and sections to show that there was less deposit now at the places indicated than before the existence of the outfalls. The Thames Conservancy, however, in the interests of the navigation of the river, applied last summer to Captain Calver, R.N., the well-known marine surveyor, to report to them whether any banks were being formed in the river bed by the deposit of sewage, and after an investigation extending over four months, he has just presented his report. After pronouncing his decided opinion that an accumulation of sewage matter from the outfalls has occurred in the river channel above them, and stating that the discharge of sewage into any river should be abandoned, and indicating how the lower portions of the Thames have been polluted by the sewage, he gives the following general conclusions:—

1. "Unquestioned documentary evidence shows that foul and offensive accretions have recently formed within the channel of the Thames.

2. "That a material portion of these accumulations is in the immediate neighbourhood of the Metropolitan sewage outfalls, and that they have formed since the outfalls came into operation.

3. "That careful analyses show a perfect identity to exist between the constituents of the recently-formed mud and those of the Metropolitan sewage.

4. "That the sewage discharged at Barking-creek and Crossness contains matter in sufficient quantity to account for the mass of the new formation.

5. "That the character of the tidal streams in the neighbourhood of the outfalls as to direction and force is the effective cause of such accumulation.

6. "That the increase of soil in Woolwich Reach and elsewhere above the outfalls has been derived from the sewage discharge, and that the operation of accretion has been effected by the superior disturbing and transporting power of the flood-stream, aided by the peculiar character of the suspended material.

7, and lastly: "That some statements connected with current action and the purification of sewage after discharge, brought forward in support of the system of sewage discharge at the Metropolitan outfalls, are not tenable."

These conclusions are directly opposed to the statements furnished at different times by Sir Joseph Bazalgette, and with such a conflict of evidence between those who have the best means of procuring accurate information, it is difficult to arrive at any satisfactory conclusion as to the real effect of the discharge from the outfalls or the neighbouring portions of the river.

The course of sewage discharged in a tidal river is a complicated problem; it is carried down by the ebb and brought up by the flood tide, and according to calculations made some time ago by Sir J. Bazalgette himself, the sewage matter discharged into the Thames travels towards the sea only at the rate of five miles in a fortnight.

From this calculation as a basis, Captain Calver draws a vivid picture of the state of the Thames between Blackwall and Gravesend, with its burden of oscillating sewage matter. He says "the daily discharge from the outfalls has been stated as 120,000,000 gallons, or 19,246,000 cubic feet, so that 423,412,000 cubic feet, or 22 days' discharge, represents the aggregate amount of sewage in the oscillating section, being about a fifth part of the whole contents of the river within the same limits below the level of ordinary low water. This vast mass of polluted water, eight miles long, 750 yards wide, and 4½ft. deep, charged with offensive matter both fluid and solid, moves up and down the channel four times daily between Gravesend and near to Blackwall, dropping its solid burden wherever a reduction in the rate of the current or still water may favour deposit."

"Again, the matter which falls from the sewage section during its daily oscillation is probably added to at the time of land floods. When these occur, additional relief is needed at the outfalls to prevent the marshes in their neighbourhood from being covered by sewage over-flow; the sewage, accordingly, is let out by gravitation direct from the main sewer at the southern outfall (and, it is asumed, from the northern one also) when the level of the river is 13 feet below Trinity high-water mark, continuing to run until the same level is reached on the flowing tide; this is said to occur about 12 times a year. On other occasions of rain-fall, and much more frequently, the sewage is let out from the reservoir at half-flood, ceasing at half-ebb,

which corresponds with the level of the bottom of the reservoir, as before remarked. The extreme distance to which this exceptional discharge of sewage is carried up the channel of the Thames and through the Metropolis depends on the outfall it is discharged from and upon the strength of the tide. At springs, sewage issuing from the outfalls at half-flood will ascend to Hookness from the southern outfall, and to the middle of Blackwall Reach from the northern one, while that entering the river at low water will reach the Temple pier from the southern outfall, and Chelsea Suspension-bridge from the northern outfall. It is scarcely to be expected that sewage can range over this extensive course without leaving some marks of its presence, and it is far from improbable that the occasional tendency to form deposit in front of some of the London wharves, &c., which has been noticed of late years is due to this cause.''

With regard to the deposit of sewage matter it has been urged that if no deposit occurs when the sewage is travelling down the sewers at a rate of 1½ miles an hour, it is impossible that any deposit can take place when the sewage is discharged into a river flowing at the rate of 2¾ miles an hour, but such an argument shows an utter ignorance of the effects of a slack tide on suspended matter. It is when the tidal flow is checked or stopped at high and low tide that the deposit occurs, and this takes place in the whole mass of oscillating sewage four times in every twenty-four hours, for a shorter or longer period according to the state of the tides, the amount of fresh water coming down, and the direction and force of the wind. Captain Calver says that the flood-tide has a greater carrying form than the ebb tide, and that consequently the sewage matter is gradually deposited higher and higher up the river. Any advantage that the flood-tide can possess in carrying power, must be due to the greater specific gravity of the salt water brought up by the flood-tide, compared with the mixture of salt and fresh water discharged on the ebb tide; but this cannot have much, if any, effect against the excess of water coming down, and the downward inclination of the river bed, otherwise rivers would soon silt up. It appears that the scour of the river has been improved of late years, in consequence of dredging operations and the reconstruction of some of the bridges, which has doubtless, hitherto, prevented any very large accumulation of sewage matter; but Professor Williamson's analysis, in 1876, of the deposit in the river, and Captain Calver's report, show that more or less sewage matter is deposited above and below the outfalls. This is an unsatisfactory result after the large expenditure incurred in the main drainage works. The present situations of the outfalls were chosen merely to save the expense of taking the sewers further down the river.

The state of the river between Blackwall and Gravesend requires continued careful investigation, and if it should appear that the accumulations are increasing and liable to become a nuisance, the Metropolitan Board of Works must be warned in time that they must be prepared to provide some efficient method of purification, and not be allowed to be the only body along the whole course of the Thames that may discharge sewage into the river, but be made to conform to the rules enforced on other towns.

LIQUEFACTION OF OXYGEN, NITROGEN, HYDROGEN, AND AIR.—During last month it was announced that oxygen had been liquefied by two different investigators independently of each other. The priority of discovery by a few days lies with M. Cailletet, a French ironfounder, who finds that when oxygen is subjected at a temperature of 29° C., to a pressure of 270 atmospheres and then suddenly relieved from it, the gas takes the form of a cloud of liquid or solid particles. M. Raoul Pictet, a physicist, of Geneva, has also liquefied oxygen on a somewhat larger scale. His process consists in heating chlorate of potash in an iron vessel and accumulating the oxygen, which is given off in a thick glass tube until it is under a pressure of 320 atmospheres. It is then chilled to a temperature of 140 degrees below zero by a freezing mixture of solid carbonic acid. This freezing mixture is allowed to remain for many hours round the glass tube containing the oxygen. If the tube is then suddenly opened, the cloud which M. Cailletet obtained is produced, together with a quantity of liquid oxygen which flows out of the tube. When liquefied, oxygen is reduced to less than $\frac{1}{1000}$ of its original volume. No less than three of the so-called incompressible gases were liquefied during the past year by M. Cailletet—namely, nitric oxide, carbonic oxide, and oxygen.

The new year was ushered in with the liquefaction of nitrogen, hydrogen, and common air, by M. Cailletet. These achievements verify the prediction of Lavoisier, the founder of modern chemistry, and complete the work which Faraday began in his liquefaction of chlorine gas. The so-called permanent gases have now all been reduced to the liquid state, and in conformity with the physical theory that every substance may assume the solid liquid and gaseous state under proper conditions, chemists are already anticipating the time when it will be possible to produce solid hydrogen and solid air. M. Cailletet took pure and dry nitrogen, compressed it to 200 atmospheres pressure at a temperature of + 13° C., then suddenly relieved it of pressure, when it promptly condensed into a mist of finely divided drops of liquid nitrogen. Little by little the liquid gathered in the centre of the tube and remained there. The whole duration of the phenomenon was about three seconds, and the experiment was repeated many times in presence of several eminent physicists at the laboratory of the Normal School, Paris.

Hydrogen has always been regarded as the most incoercible gas, because of its low density, which renders it almost an ideally perfect gas. M. Cailletet,

in presence of some distinguished colleagues, has also obtained satisfactory evidence of its liquefaction. With hydrogen under a pressure of 280 atmospheres, and suddenly relieved from it, an excessively fine mist formed itself throughout the length of the enclosed gas, then quickly disappeared. The extreme tenuity of this hydrogen haze — a kind of shimmer, as M. Berthelot, one of the witnesses, aptly called it— and also its swift return to the gaseous state, are in perfect accord with the properties of hydrogen with respect to other gases.

The liquefaction of air is necessarily rendered feasible by the liquefaction of oxygen and nitrogen, but M. Cailletet made it the subject of direct experiments and with foreseen success. The air was of course previously dried and deprived of its carbonic acid. Since the discovery of the satellites of Mars and of oxygen in the sun, these experiments have been the most important event which has occurred in the scientific world.

An International Exhibition at the Cape.—It has been officially announced that a second International Exhibition will be opened at Cape Town in April of this year. The commerce of the Cape has largely increased within the last few years. From 1866 to 1875 the imports increased from under two millions sterling to over five millions, and the exports from two and a half to four and a quarter millions. The exports consist chiefly of live stock, copper ore, tallow, hides, sugar, indigo, coffee, arrowroot, &c. Diamonds are usually sent in parcels or letters, and there are no Customs returns for them; but it is estimated that the value of those exported up to the present time amounts to about twelve millions sterling. The coming exhibition will be under the especial patronage of Sir Bartle Frere, Governor of the colony. The list of proposed exhibits includes articles of food; articles for domestic use, including clothing and furniture; agricultural implements, machinery, and materials of construction; means and appliances for education; vehicles, tents, and tools connected with travelling, camping, and settling. A special class embraces the somewhat heterogenous elements—tobacco, drinks, ropes and boats, fire extinguishers, and *papier maché* ornaments.

Extensive mines of fossil carbon have been discovered at Shackleford, in Texas.

An expedition has left New York for the purpose of recovering treasure from the sunken hulk of the *San Pedro Alcantara*, a Spanish war vessel, which was wrecked in 1816 near the Island of Cuaga off the Coast of Venezuela. The *San Pedro* contained in gold, silver, and precious objects, a treasure amounting to over a million sterling. In the year of the wreck, Captain Goodrich, of Newburyport, succeeded in recovering over £5,000 from the ship by means of divers. In 1845 some £40,000 were brought to the surface, and in 1856 two Americans raised £60,000 more. The new expedition hopes to recover the remainder.

Volcanic Island. — A volcanic island suddenly rose from the sea off the coast of Terra del Fuego last December, in lat. 65° S., and long. 75° W. It was sighted by a Dutch sailing ship, and it is reported that the captain tried to land on it, but flames were seen issuing from the ground, and the sea around was in a boiling state. On withdrawing from it, the island began to sink, and in a few hours had wholly disappeared.

Flooding the Sahara.—The vast hollow of El Juf, in the Sahara desert, is 500 miles long by 120 wide, and 200 feet below the sea level. It was formerly connected to the Atlantic by the Sakiet el Hamra, or Red Channel, now filled up with sand. Mr. Donald Mackenzie proposes to reopen this channel and flood the hollow, so as to create an inland sea in North Africa, which would increase the fertility and facilitate the commerce of the surrounding region.

The Channel Tunnel.—The preliminary work of boring is going rapidly forward. At Sangatte a shaft 100 metres deep has been sunk, and a trial gallery is being driven along the proposed course of the tunnel. The drift is kept dry by two powerful pumping engines.

A Petroleum Geyser.—In sinking an oil well, recently, about five miles north of Wilcox, Elk County, Penn., an intermittent flow was struck, which presents many of the features of a geyser. The well spouts for two minutes, and then is quiet for eight minutes. During the spouting it sends up salt water, inflammable gas, and a small quantity of oil to a height of 150 feet. By lighting the gas at night a magnificent spectacle is obtained, the gas burning brilliantly and illuminating the column with prismatic hues. The roar of the burning gas is said to be audible within a radius of some miles. In the city of Earl, Penn., the flow of gas from wells is largely utilised for heating and illumination, the product of not fewer than fifteen wells being thus employed.—*New York Tribune*.

City Notes.

Old Broad Street, Jan. 14th, 1878.

In these columns we have repeatedly urged that a spirit of independence should be maintained by the telegraph companies; and, believing that independence is out of the question where monopoly exercises its baneful sway, we have opposed, with unswerving fidelity, any and every attempt on the part of the monopolists to extend their mischievous operations. Failing any fresh information from the United States respecting the New Cable scheme, it may be worth while for us to state once more, in as few words as possible, why we object to monopoly alike in the interests of telegraph engineers, of contractors, and of shareholders. Look at the effect upon engineers.

Amalgamation simply means less work to do for them; it means also lower salaries to those who retain employment. The swelling of capital account, as in the case of the Anglo-American and Direct Companies, which will, if possible, go on increasing with every new scheme launched, must inevitably lead in the end to a substantial decrease in the profits; and the directors, even if it be against their will, will be driven to desperate expedients to reduce expenditure. The engineers will be amongst their first victims. To them, then, the effects of monopoly cannot but be disastrous. In the case of contractors, the evil results are more on the surface. What have they to hope for with a market almost closed against them? The check given to telegraph enterprise by the success of the monopolists cannot fail to be prejudicial to their interests. They, too, ought not to need any incentive to oppose the multiplication of amalgamation schemes. But the interests of shareholders are also at stake,—perhaps a great deal more nearly at stake than some of them imagine. It is necessary that they should be perpetually on the watch. They may not require to be reminded that the process of buying up and amalgamating, in order to obtain a monopoly, is a costly luxury; but do they sufficiently realise how costly? Do they see that it is like capital account rapidly outgrowing its dividend-earning power? If they do, no caution should be wanted from us. And yet the monopolists are very skilful strategists. It appears to us that shareholders are *not* alive to the dangers which threaten them. Have they not allowed investments to be manipulated without a protest? Have they not been tongue-tied at meetings when sophistries have been expounded, and resolutions, which were manifestly calculated to injure their interests, have been passed "unanimously"? Why does this man wait for that one to act, and the other procrastinate until a more convenient season arrives. One of these days, when dividends are impossible, there will be an outburst of lamentation at lost opportunities. But it is not too late for shareholders to stay the chariot-wheels of the monopolists, though they have made alarming progress.

Here we have a remark or two to make about the public. We do not know that the public requires to be warned, for it usually looks pretty well after itself—even if it makes no sign. We have always for instance, contended that it will not go on paying three shillings a word for its messages. Now that there is a probability that it may send them for ten-pence, does any sane person really fancy it will long endure three shillings? Half the money for another cable to America is already subscribed, and, as we mentioned in our last issue, there is now a bill before the House of Representatives in that country, embodying a scheme for an Anglo-French American cable. But another cable, lay it who may, is not a dim possibility—it is a rapidly approaching event. The monopolists may plot and plan as much as they list; but ultimately defeat awaits them. We are quite aware that when a new company is fairly floated, Mr. Pender and his friends may make advances in the hope of amalgamating it also; but if the advances are futile, what then? Will there be a bill of divorcement, and the Anglo and Direct Companies each agitate for the loosening of the bonds they so eagerly desired might be fastened round them.

What is the sum and substance of the whole matter? Why, simply, that monopoly has benefited a small part only of the telegraphic world, while by far the greater part has been injured, and the public has been made to pay the piper. But it is evident that the public will soon cease to pay, and then, shareholders, will come the hour of your darkness. We fear the employés of the companies are powerless, but we shall continue to advocate their interests, because we know that in doing so we are also advocating the interests of all who are anxious to witness the triumphant development of telegraphic enterprise. In short, the monopolists have no sort of care either for employés, for shareholders, or, for the public; their care is for themselves, and they will spare no effort to promote their own schemes, and enrich, —— their own pockets.

We don't wonder that Mr. Abbott has another good word for Telegraph Construction shares in his current circular, for Mr. Abbott is on the side of the monopolist. It is natural, no doubt, that the Telegraph Construction Company should wish to manufacture all the cables that are laid, and there is no doubt that they can lay good cables; but it does not follow that it is desirable they should lay them. The question for the shareholders of the Telegraph Companies is, can they get their cables made as well or better, and at less cost, than by the Telegraph Construction Company? If they can, it is useless to puff its wares. It is folly for Mr. Abbott, or any one else, to fancy that it has nothing to dread from competition. But do they fancy something else? Are they afraid that when the monopoly ring is broken up, "important contracts" will be committed to other hands, and the shares which are now "a decidedly cheap investment," will be a drug in the market.

It was stated a few days ago that there is some probability of the negotiations which were suddenly broken off between the Manchester and Sheffield Railway Company and the Great Northern and Midland Companies being resumed. Certain proprietors of Sheffield stock were, it was said, anxious to bring the matter again before their brother shareholders. We can readily understand they were. All the same, there is not now the least likelihood of an amalgamation between the companies in question. The Sheffield Company had its opportunity, and failed to take advantage of it. The Great Northern and Midland Companies had their hour of weakness; it is past. It may suit the purpose of unscrupulous speculators to propogate rumours that union is still probable. But no sane person, unless he be exceptionably ill-informed, really supposes that such a thing is even within the limits of possibility. It is satisfactory that a scandalous attempt to force up the price of Sheffield stock has been almost entirely futile.

Broadly speaking, every report of impending amalgamation, whether between cable, railway, or tramway companies, may be regarded as unreliable. Unhappily, there exists in the city a certain number of unprincipled stock-brokers and financiers whose sole mission in life is to make money—honestly if possible, no doubt, but make it, somehow, they must. With these persons scheming of all sorts and kinds is essential. It is no concern of theirs, they would say, if credulous fools believe what a bribed newspaper hack or a mendacious circular puts forth. We do not imagine it is; words of regret would come strangely from the lips of men who would despoil the widow and the orphan. Nevertheless, it may be worth while to give utterance to an emphatic warning on the subject. It may, at least, have the effect of reducing the number of victims.

Speaking of amalgamation, there is one union against which little can be urged. If the ruling spirits of the Metropolitan and Metropolitan District Railway Companies could only see their way to get over certain little difficulties, and work amicably together, the benefit accruing to the shareholders would be very considerable. The shareholders will not, in fact, ever reap the advantages they ought to reap, or the public either, until the amalgamation takes place.

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FROM A PHOTOGRAPH BY MR. E. J. MAYALL.

CHARLES WILLIAM SIEMENS.

Dr. Charles William Siemens, F.R.S., the celebrated engineer, who has gained a world-wide reputation through his researches on heat and electricity, his economical application of fuel, his metallurgical processes, and his scientific investigations, was born at Lenthe in Hanover, on the 4th of April, 1823. He received his education at the Gymnasium of Lubeck, the Art School of Madgeburg, and the University of Göttingen. Here he had the advantage of sitting under Wöhler and Himly, and laid the foundation of that knowledge in mechanics, chemistry, and physics, which he has ever since so well applied to useful results.

In 1842 he entered as a pupil the Engine Works of Count Stolberg, and there became acquainted

with tools and their uses, and with methods of work, thus obtaining that practical knowledge which helps to make the engineer.

In 1843 he visited England for the purpose of introducing a method of gilding and silvering by galvanic deposit, principally the invention of his elder brother, Werner Siemens. He returned immediately to Germany, and in the same year, the brothers invented a Differential Governor for Steam Engines. In 1844, C. William Siemens again came to England to patent this invention, and has ever since remained in this country, of which he became a naturalised subject in 1859.

In the same year (1844) was brought out the process of "Anastatic Printing," which invention was due to the two brothers, and was described by Professor Faraday in a lecture before the Royal Institution in 1845.

About this time Mr. Siemens was variously engaged: he was at times occupied upon railway works, upon improvements at Hoyle's Calico Printing Works, and upon several other inventions. Between the years 1844-47 he was occupied *inter alia* with the Chronometric Governor, the regulating action of which results from a differential movement between the engine and a chronometer. Several of these governors are in use at the Royal Observatory, Greenwich, for controlling the motion of transit and recording instruments.

In 1846 was introduced the double cylinder air-pump, in which the two cylinders are so combined that the compressing side of the first or larger cylinder communicates with the suction side of the second and smaller cylinder, whereby the limit of exhaustion is very much extended.

It was in 1847 that Mr. Siemens turned his attention to the then new study of the dynamical theory of heat, and also to the use of a regenerator for recovering that portion of the heat which presents itself at the exhaust port of a caloric engine.

The same year he constructed in the factory of Mr. John Hick, of Bolton, a regenerative engine using superheated steam, the principle attempted to be realised being to recover the latent heat of the steam by restoring to the same for each stroke only such an amount of heat as was expended in the production of mechanical effect. The fuel of the engine was consumed also by air previously heated to a considerable point by means of a regenerator or heat exchanger.

The first engine constructed upon this principle was of four horse-power. An engine of twenty horse-power was placed in the Paris Universal Exhibition of 1857, but not realising altogether the expectations of its designer, another of six horse-power was substituted, made by M. Farcot, of Paris, and was found to work with considerable economy. The use of superheated steam was attended with difficulty, however, and the invention has not been very extensively introduced.

In 1851 Mr. Siemens introduced his water-meter, which, both in its original and in a modified form, has been very extensively used both in this country and on the continent, the number in use being nearly 30,000. They act equally well under all varieties of pressure, and with constant or intermittent supply; they have been tested to register the flow to within 2½ per cent. of the measured quantity, and are manufactured in this country by Messrs. Guest and Chrimes at Rotherham, and in Berlin by Messrs. Siemens and Halske.

Between the years 1856 and 1861, Mr. Siemens, in conjunction with his brother Frederick, worked out the Regenerative Gas Furnace, an invention with which his name will ever be remembered. This furnace is too well known to require a detailed description, and we shall here only explain its main features. There is first the gas producer, a brick chamber with three openings, one above for the admission of fuel, which is closed after a charge is thrown in, a second below for the admission of a regulated quantity of air, and a third above for the exit of the gas, which consists of carbonic oxide, mixed with hydro-carbons, and diluted with air. The gas after rising perpendicularly to some height from the producer, traverses an overhead tube, and then descends a downtake to the foot of the regenerators. By this arrangement there is a continual flow of gas towards the furnace, the downward portion of the current to the furnace being always heavier than the upward from the producer. The regenerators are four chambers containing fire-bricks, so arranged as to allow a free passage of air or gas through them; these fire-bricks will be heated if hot air or gas pass through, and will heat cool air or gas. The regenerators are divided into pairs of two, one regenerator of each pair being connected by means of a suitable valve with the atmosphere, and the other with the producer. The furnace is placed above the regenerators, and there are two ports entering it, the one from the gas, the other from the air regenerator, and two leaving it to the other gas and air regenerator. When in action, and the furnace is at a certain high temperature, air enters the air regenerator from the atmosphere, and gas the gas regenerator from the producer; these are heated as they traverse the brickwork, and finally combine in the furnace, adding the heat of the brickwork through which they have passed to that of chemical combination or combustion: the heat melts or heats the work, and then the product of combustion passes down the exit regenerators which it heats to a high temperature; after a certain time, generally half an hour, the direction of the current is reversed by reversing valves. Each pair of regenerators is thus alternately employed to heat the entering air and gas and cool the products of combustion, which finally leave the chimney at a comparatively low temperature.

By this arrangement of furnace great economy is attained, great cleanliness in working, and purity of flame; but it has been principally valuable as, owing to the great heat obtainable, it has enabled metallurgical processes to be employed, which cannot be attempted in ordinary furnaces. The temperature is limited theoretically by the point of dissociation, and practically by the resistance to fusion offered by the refractory materials used in its construction.

This is hardly the journal in which to refer at length to metallurgical processes, but a memoir of Dr. Siemens would certainly be most incomplete if we did not refer shortly to his process of producing steel by direct fusion of the ores and other raw material.

Since 1867 Dr. Siemens has manufactured steel on the open hearth of his regenerative gas furnace.

Reaumur, in 1722, made steel by the fusion of malleable iron with cast iron in a clay crucible, and, acting upon this hint, Dr. Siemens persevered in his experiments, and thousands of tons of steel are now made of nearly the same mixture upon the open hearth of the furnace that has just been described. But it has taken years of hard labour, close attention to important details and circumstances, great powers of resource, and a commanding determination to overcome opposition, to say nothing of the expenditure of much capital before this result has been attained. Dr. Siemens made many attempts in England, and studied the question with his friend, the late Mons. L. Lechatelier, Inspecteur Général des Mines. Meanwhile Messrs. Emile and Pierre Martin, who had received licenses from Dr. Siemens, succeeded in producing cast steel by melting together pig iron, cast iron, and spiegeleisen. This kind of open-hearth steel making is now known as the Siemens-Martin process, and may be described as follows:—First, a bath of melted pig iron is formed on the bed of the furnace, and iron or steel scrap is added, till, by repeated trials, a sample taken out and cooled in water is found to be of the right temper. Then ferro-manganese or spiegeleisen is added, and when this is melted the charge is drawn off. The consumption of coal is from 13 to 14 cwt. for every ton of steel produced. In a modification of the process introduced into extensive practice by Dr. Siemens, pig iron is melted on the furnace bed, and iron ore then added in the proportions of from 20 to 24 cwt. of ore to five tons of pig iron.

Dr. Siemens is now erecting furnaces which will hold a charge of 10 tons, and will produce 20 to 30 tons of steel in 24 hours. This steel is much employed for all kinds of machinery purposes where high quality and uniformity are essential, and also in the construction of steel ships and boilers, which are gradually supplanting iron.

While introducing the Open Hearth Process as a considerable advance in the mode of production of steel, Dr. Siemens has been working to accomplish the further result of making steel and iron direct from the ore, and with this end in view, he constructed, in 1866, his sample steel works at Birmingham, and, in 1867, he sent several samples of steel produced in this manner to the Universal Exhibition at Paris. The first experimental attempts led to the construction of the Rotatory Furnace, by which that end is effected; and although it is as yet only employed upon a limited scale, its use is gradually extending. The latest results obtained with this furnace, were communicated at the autumn meeting of the Iron and Steel Institute, at Newcastle, last year.

It was in 1868 that he originated the Landore Siemens-Steel Works, which manufacture upwards of 1,000 tons of cast steel per week, and are, therefore, among the most extensive works of the kind in this country.

The Steel Company of Scotland, Vickers and Co. of Sheffield, the London and North Western Railway Works at Crewe, and other leading works, both in this country and abroad, are licensed by Dr. Siemens for the production of steel according to the processes we have described; the works in this country are capable of producing 250,000 tons, whilst the actual production last year in finished articles was over 140,000 tons.

Ever since the year 1848, Dr. Siemens has been interested in telegraph engineering. In 1858 he established, with his brother, Dr. Werner Siemens, and Mr. Halske, of Berlin, and with his brother, Mr. Carl Siemens, then of St. Petersburg and now of London, Siemens, Halske, and Co.'s Telegraph Works in London, which are now known as those of Messrs. Siemens Brothers. They have been considerably extended since their formation, and from them telegraph lines have been shipped to various quarters of the globe. The Indo-European telegraph line was constructed by Siemens Brothers in connection with their Berlin house, as also the North China Cable, the Platino-Brazileira Cable, and others. But the most important telegraphic enterprise that Dr. Siemens has been identified with, is that for which the celebrated steamship *Faraday* was built.

This vessel, constructed according to designs of which the conception was due to Dr. Siemens, was employed in 1874 in laying the Direct United States Cable, and succeeded in paying out nearly the entire length in perfect condition; but, as the stormy season had set in, it was deemed advisable to buoy the cable and to defer any further attempts to finish laying it until the summer of 1875. The *Faraday*, therefore, returned to England, and during the winter was refitted, and in June succeeded in completing the work. But a fault was discovered, and another return to England for a piece of cable of sufficient length to repair the damage was found necessary. Early in September the cable was put in complete working order, and on the 15th was opened to the public for the transmission of messages.

The *Faraday* is a peculiar vessel, having stem and stern alike. She was built by Messrs. Mitchell and Co., at Newcastle, and is 360 ft. long, with 52 ft. beam and 36 ft. depth of hold. She has a rudder at each end, and either of them can be rigidly fixed when required. Two screw propellers, driven by a pair of compound engines, furnish the motive power, and are so placed at a slight angle to one another, that the vessel can turn in her own length when the engines are worked in opposite directions. As the ship can steam backwards of forwards with the same facility, in case a fault is discovered in the cable in the bow compartment, it is not necessary to pass the cable astern before hauling it in, but merely to reverse the motion of the ship, having the stern rudder fixed and making the bow the stern, and a small engine hauls in the cable over the drum just employed to pay it out. The *Faraday* was fitted out with everything necessary for laying the cable, as well as for grappling and recovering lost cable, and a steam launch carried on deck to be used in landing shore ends, was found to be of much service.

The Direct United States Cable, in the successful completion of which Mr. Carl Siemens, Mr. L. Loeffler, and several of the leading employés of the firm of Siemens Brothers, so zealously co-operated, must be regarded as an important step in Telegraph Engineering.

In the scientific world the labours of Dr. Siemens have been appreciated. He is a member of many learned societies. He was elected a fellow of the Royal Society in 1862, and in the year 1869 and 1870 he served on its council. He has long been a

prominent member of the Institution of Civil Engineers, being a member of its council and of that of the British Association. He, at intervals, has been one of the managers and vice-president of the Royal Institution, and has been president of the Institution of Mechanical Engineers. He was also the first president of the Society of Telegraph Engineers, and has been again this year unanimously elected to this honourable position. He was elected president of the Mechanical Section for the conferences held under the auspices of the Loan Exhibition, and gave a valuable inaugural address on "Measures." The Iron and Steel Institute claim him as one of their most honoured members, and last year he was elected president of the Institute, a position which he still holds.

He was elected president of the International Patent Congress at Vienna, and shortly after an honorary member of the Austrian Society of Engineers and Architects.

In the February of last year, after his recent visit to America, he was elected an honorary member of the American Philosophical Society, and in October of the same year was elected with Mr. Bessemer the first honorary members of the very ancient Society the Gewerbe-Verein of Berlin.

In 1871 he was brought into the Athenæum Club by the Managing Committee, and has since then served as a member of the same committee. He is also a member of the Philosophical and Royal Society Clubs.

Dr. Siemens has presented many scientific papers to these societies. His first paper was presented to the Institution of Civil Engineers on the 17th of May, 1853, and was entitled, "On the Conversion of Heat into Mechanical Effect." It was the first paper published in this country which considered the subject of heat engines from the point of view of the mechanical theory of heat, and, although a quarter of a century has nearly elapsed since it was read, it may be to-day taken as a guide to the subjects to which it has reference. Between this period and 1860 he described his governor, steam engine, and water-meters, in papers to the Institution of Mechanical Engineers.

In 1862 he presented to the Institution of Civil Engineers a very elaborate paper "On the Electrical Tests employed during the construction of the Malta and Alexandria Cable, and on insulating and protecting submarine cables."

In 1863 he prepared a paper on "Observations on the Electrical Resistance and Electrification of some Insulating Materials, under pressures up to 300 atmospheres," which was published in the British Association Report for that year. The two main points brought out were that the inductive capacity of gutta-percha is not affected by increased pressure and that of india-rubber is diminished.

In 1866 Dr. Siemens presented to the Royal Society a scientific paper on "Uniform Rotation," which is printed in the Philosophical Transactions.

On the 14th February, 1867, was read his paper "On the conversion of dynamical into electrical force without the aid of permanent magnetism," which is peculiarly interesting as being the first scientific enunciation in this country of the dynamo-electric principle upon which the most powerful light producing machines depend.

Another scientific paper presented by him to the same Society in 1871, "On Electrical Resistance," was made the Bakerian Lecture for that year. It treats of a method of measuring variation of temperature by variation of electrical resistance ; and the new instruments described in this paper, the electrical resistance thermometer and pyrometer, in connection with the differential voltameter, are already being appreciated as valuable auxiliaries in thermometry, and in metallurgical research. These instruments allow of the measurement of temperature without any break, from the lowest attainable degree of cold to a temperature approaching that of the fusion of platinum.

Between this period and 1876 he read various papers, principally on metallurgical questions, before the Iron and Steel Institute, the Chemical Society, and the British Association.

In February, 1876, he read a paper "On the Action of Light on Selenium," before the Royal Institution, and presented his paper "On determining the depth of the Sea without the use of the Sounding Line, and on an Attraction Meter," to the Royal Society, which has since been published in the Philosophical Transactions of that body.

Many other papers presented by Dr. Siemens to scientific bodies (notably that on puddling iron, read before the British Association in 1868, showing incontestably that the carbon and silicon can be made to leave the pig metal by the action of the fluid oxide of iron present, alone), all treating of subjects of varied scientific and practical value, might be here considered, but we must be content to refer our readers for particulars to the Transactions of these bodies.

In a short memoir of this kind, and one treating, moreover, of a busy worker, whose every day and hour is employed, although much has been said, a great deal remains unsaid, and we shall complete this with a list of the awards Dr. Siemens has obtained.

The Society of Arts presented him with its gold medal for his regenerative condenser in the year 1850, and the Institution of Civil Engineers, in the Session 1852-53, with its Telford medal for the paper already referred to.

In 1851 and 1862, Dr. Siemens received prize medals of the London Exhibition, and in 1867 was awarded a Grand Prix at the Universal Exhibition of Paris for his regenerative gas furnace and steel process. In 1869 the degree of Doctor of Civil Law, *Honoris causâ*, was conferred upon him by the University of Oxford, and in 1874 he received the Royal Albert medal for his researches on heat, and for his metallurgical processes. In 1875 he received the Bessemer medal of the Iron and Steel Institute "in recognition of the valuable services he has rendered to the iron and steel trades by his important inventions and investigations."

Dr. Siemens was appointed first a Commander and subsequently a Dignatario of the Brazilian Order of the Rose. It is not often that life-long exertions like these are recognised by governments, and hence among the few recognitions of this description, this from the Emperor of Brazil must have been of a very pleasing character as coming, moreover, from a Potentate so qualified to judge of scientific and technical merit.

CLAMOND'S THERMO-PILE.

It is well known that Clamond's Patent Thermo-Pile, in its earlier form, failed to bear up under the ordeal of continued use. It has not, however, on that account been abandoned altogether. Further improvements have been made, and it is hoped that its failings will thereby be overcome, while its merits are brought more conspicuously out. These improvements are embodied in an English patent, No. 1583, of 1877. They relate to the casting and forming of the thermo-electric elements themselves, and to the manner of grouping them together into a pile or generator.

The current obtainable from a thermo-electric element or pair, depends, of course, on the two metals employed, the difference of temperature maintained between the ends of the thermo-electric bar, that is to say between the junction of the metals and the free ends, and the resistance of the bar. With a given pair of metals the strength of current available depends solely on the difference of temperature kept up and the resistance of the bar; the greater the difference of temperature and the less the resistance of the bar, the greater is the current strength obtained. But with the stout bars employed in thermo-piles, electric resistance may be neglected. A certain proportion or relation must always exist between the section and the length of a bar, in order that the two extremities may be easily maintained at very great differences of temperature. The result is that when intense currents have been required, it has been the custom hitherto in constructing thermo-piles, to increase the length and thickness of the thermo-electric bars conjointly; but this plan entails both heavy and costly apparatus, and necessitates the employment of very large masses of metals or alloys. The first improvement in the new patent is designed to remedy this inconvenience by the intervention of a partition or plate of some material, which is a bad conductor of heat and electricity, such as amianthus, terra-cotta, or mica, between the two ends of the thermo-electric bar, without breaking the metallic continuity of the latter, and allowing sufficient sectional area of metal to connect both ends of the bar. By means of this heat screen of non-conducting material, partially dividing the bar into two parts, the heat from the hot end is in great part prevented from radiating and being conducted to the cold end.

FIG. 1.

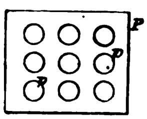


FIG. 2.

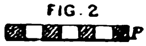


FIG. 3.

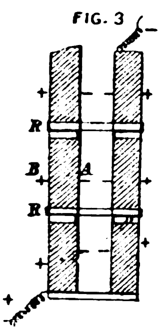


FIG. 4.

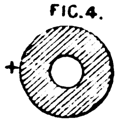


FIG. 5.

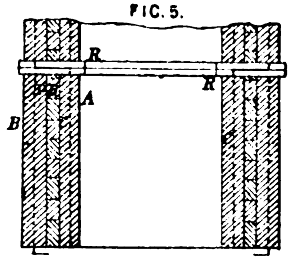


FIG. 6.

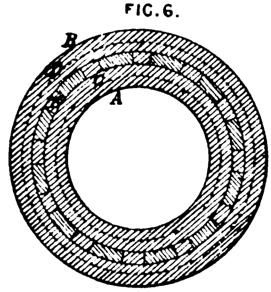


FIG. 11.

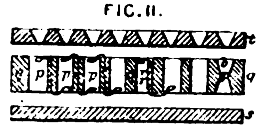


FIG. 7.

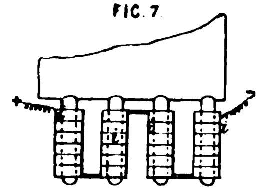


FIG. 8.

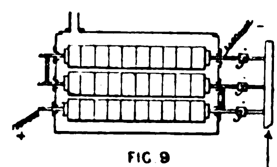


FIG. 9.

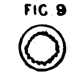


FIG. 10.

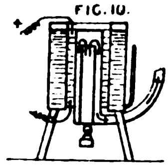


Figure 1 represents a plan, and figure 2 a section of this non-conducting diaphragm such as would be employed for a single square thermo-electric bar, *p* and *p* being holes through which the bar is cast, so as to make the alloy continuous. If such a plate be placed in a mould for casting the bar, the metal on each side of it will be united by little cylinders of metal through the holes. Bars thus made are like partitioned metal plates, a form which permits of their sectional area being increased without increasing their length. Great differences of temperature with a very small distance between the pole plate, and consequently a much greater production of electricity with less metal employed and less heat expended, are the results. This diaphragm, as the patent points out, fulfils, in some degree, the function of a porous vase in a voltaic cell, which, while putting two liquids

in contact, in such a manner as to permit the passage of electricity, prevents them mixing too quickly.

Figure 11 represents another mode of making elements suitable for the construction of small thermo-piles for domestic purposes. The figure is a section of a group of elements, *q q* being a perforated plate or flat cylinder of plaster of Paris, earthenware, or other non-conductor of heat and electricity. *p p* are perforations into which a thermo-electric alloy (say two parts zinc and one part antimony) is cast, *r r* are wires of German silver, or other thermo-electric metal, one end being cast into the alloy at the bottom of one pole, the other end passing through a hole in the material of the diaphragm to the top of the next pole, where it is likewise cast into the alloy. If preferred, the wire may be coated with asbestos paper, or other insulating material, as shown at *r r*, and cast into the alloy itself. In either case the end of the wire is curved into the form of a ring, so as to give ample conducting surface to the metal to ensure good contact. In this way the thermo-electric junctions are formed and connected to each other "in series." The perforations in the diaphragm may with advantage be formed like a double cone, as shown at *b p*, so as to retain the alloy firmly in its place. The plate *s*, of earthenware or metal, is the bottom of the mould or hearth on which the diaphragm is laid when the casting is made; and *t* is an upper plate pierced with holes, which are arranged opposite the holes in the perforated plate, so that the separate bores may all be filled at once, by one ladleful of the melted alloy. The diaphragm with its accompanying plates *t* and *s*, may be curved in the form of a segment of a circle, so that two or more segments placed together may form a cylindrical battery. Small piles so formed can be heated over an ordinary gas flame or lamp chimney.

This leads us to the second new improvement: the manner of building up the thermo-electric elements into a pile or battery. The general form selected for the pile is that of a large hollow upright tube, with the heated junctions set round the internal wall, and the cool junctions set round the external wall. Such a tubular pile can be built up of cylindrical elements, connected in series, the positive and negative poles of the pile appearing at the top and bottom of the pile respectively, or *vice versâ*. Figures 3 and 4 exhibit this arrangement of the elements. Each cylindrical element is separated from that above and below it by a non-conducting plate of mica or asbestos R; all the negative poles are shown at the interior of the tube, and all the positive poles at the exterior; while the two terminal poles of electrodes of the entire battery are shewn by wire spirals at the top and bottom. Figures 5 and 6 represent this mode of arranging the pairs in greater detail, 5 being a vertical, and 6 a horizontal section through the pile; A and B are interior and exterior protecting tubes or envelopes covering the pole tubes C D, which form the junctions with the thermo-electric alloy. To obtain good contact between the alloy and the pole tubes, the latter are made of riddled or pierced metal, or of metallic cloth, so that the molten alloy can permeate them; D is the cool or exterior pole or junction, and C the interior; while E is the non-conducting diaphragm, pierced with holes, and embedded in the thermo-electric alloy. Each single element is, therefore, in the form of a flat cylinder, compounded of the inner and outer pole cylinders C D, with their protecting cylinders A B, and the intermediate cylindrical partition of non-conducting material E; the whole being united by the thermo-electric alloy into one solid ring. Out of these single cylindrical elements the tubular pile is built up after the manner of figure 3, where three elements are shown, one above another, forming a tube. If the interior of such a tube of elements, be heated while the exterior is kept cool, the inner tube C will become a negative pole, while the outer tube D will be a positive pole in each of the elements. To connect them up in series for "intensity" currents, it is therefore necessary to join the inner pole cylinder C of one ring element, to the outer pole cylinder D of the next. In this way all the ring elements are connected together and the poles of the battery or generator appear at the ends of the tube as shown. To separate the different elements from each other in the pile layers or washers R R, of caoutchouc, asbestos, or other insulating and infusible material, such as is used for steam tubes, are employed.

The necessary source of heat for producing the thermo-electric currents may be obtained from a charcoal fire, from the waste heat of a furnace, or from gas. Where gas is employed as the source of heat, the apparatus is arranged as shown in fig. 10, which consists of a thermo-electric tube having its interior heated by a flame or brazier. The heating surface is increased by being serrated, and is protected against the immediate contact of the flame by a return flue, which causes the products of combustion to re-traverse the interior before finally passing off by the chimney. The tube is also surrounded on the outside by an envelope of cold water to act as a refrigerator to the outer poles. Two other sources of heat are utilised by the inventor, namely, the steam boiler tubes at a high temperature, and waste steam. Fig. 7 shows the first of these; the tubular piles, *i i*, being made to enclose steam boiler tubes, as in the Field boiler. Fig. 8 shows the second plan, in which tubes receiving steam to be condensed are enveloped by the thermo-electric tubes, which are isolated from them by rings of caoutchouc or other material.

The manufacture of Clamond's new pile in this country, is in the hands of Messrs. Latimer Clark, Muirhead & Co., Westminster.

TOMMASI'S TELEGRAPH APPARATUS FOR WORKING LONG SUBMARINE CABLES.

Transmitting Apparatus.

This is shown in elevation by fig. 1. B is a finger key, of which there are ten, arranged side by side in a row, so that they can be easily manipulated when signals have to be sent by their means. By pressing with the finger on the button or knob B, the spring C causes the ratchet wheel D to make $\frac{1}{8}$ of a revolution, which, by means of a toothed wheel E and pinion F, produces $\frac{1}{4}$ of a revolution of the washer G. This washer is of hardened india-rubber, and serves as nave to the four springs H set round it like spokes.

These springs, the ends of which are of platinum and which are perfectly insulated from each other, slide by the effect of the rotation of the washer G upon plates of platinum arranged for this purpose in the grooves of the pieces of hardened india-rubber I and K.

The result of these arrangements is that when one of the springs H places the zinc pole of the pile in communication with the earth, the other spring H places the copper pole of the same pile in connection with the cable or the aerial wire (accordingly as the communication is submarine, underground, or

Fig. 4.

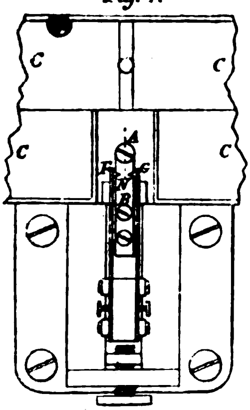


Fig. 3.

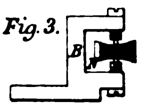


Fig. 5.

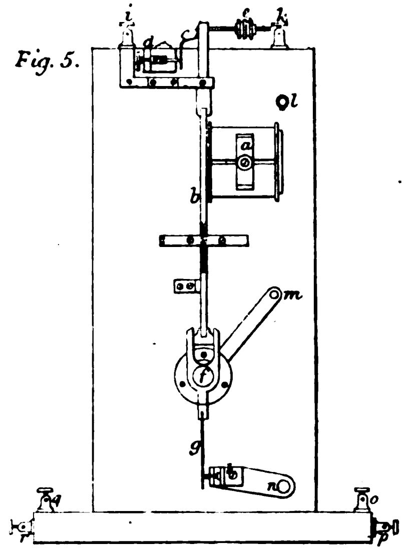
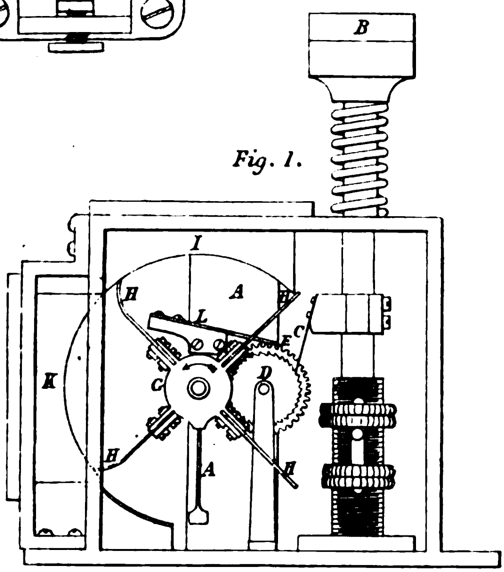


Fig. 1.



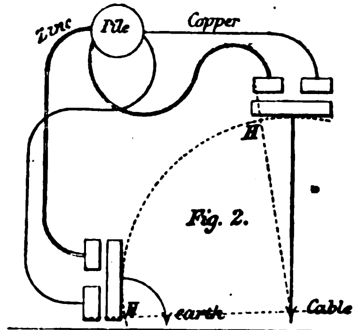


Fig. 2.

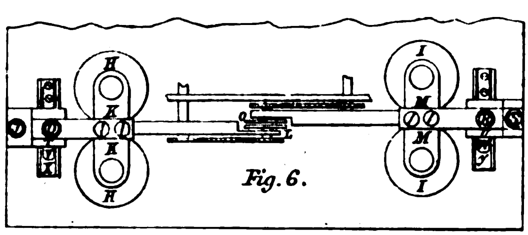


Fig. 6.

Fig. 2 shows the arrangement of these plates, which, for thorough comprehension of their working, are drawn in plan, whereas, in accordance with the position of the springs H, they should have been represented as seen in elevation.

by wires suspended from posts), and that on the contrary, when one of the springs H places the copper pole of the pile in communication with the earth, the other spring H places the zinc pole of the same pile in connection with the cable or

with the aerial wire. The result is a reversal of current at each contact established by the springs H between the short plates and the long plates fixed in the groove of the pieces I and K. Therefore, by pressing on the knob B, two successive waves of electric current are sent into the cable, both of equal duration, but always of a different designation; that is to say, if the first is negative the other is positive, and *vice versa.*

If instead of fixing one long and two short plates fixed in the grooved part of the pieces I and K, as shown in fig. 2, four or even six short and one long one are fixed therein, it is evident that by pressing on the knob B four or six successive waves of electric current of equal duration will be sent into the cable or aerial wire, and that it depends solely upon the manner in which the short plates are placed in connection with the poles of the pile whether these waves are always of a different designation; that is to say, whether a positive wave is always followed by a negative one, and *vice versa.*

By varying the grouping of these waves in the mechanism of each of the ten keys, ten different combinations may be obtained without going beyond a maximum of six waves per group, the three reversals of current inclusive.

When desired, only two knobs or studs may be used, and consequently only two combinations, one of which will represent conventionally a dash and the other a dot; the ordinary "Morse" code would be employed.

The signs produced upon the receiving apparatus (as will be seen) by nine of these combinations, represent conventionally each of the nine numbers or numerals, and the signs produced by the tenth combination represent the zero or nought.

The result of all this is that the operator or sender of the telegram or dispatch (this telegraphic dispatch being always written in figures as will be explained) has no other operation to perform than to press successively the ten knobs marked with the numbers composing the figures which he is to transmit, according to the indications of the dispatch.

If the mode of transmission adopted is the "Morse" code, in which case two knobs only would be employed, the sender has only to press with his finger on the knobs, which produce, as will be seen, a red dot and a blue dot (which conventionally represents a dot) or upon the other which produces a blue dot and a red dot (which conventionally represents a dash) accordingly as he is to send one or other of these signs.

It need scarcely be observed that by means of its spiral spring each knob or stud returns to its place directly the pressure of the finger of the operator is removed, and that this movement has no effect upon the washer G, owing to the spring L, which compels the wheel E to turn only in one direction, and also to the ratchet wheel D, which permits the spring C to rise again by sliding over its teeth, and consequently without setting it in motion.

To apply this system to aerial wires, as in these conductors, the unequal duration of the waves of electric current produce no inconvenience; an ordinary manipulator may be used, arranged so as to reverse the current automatically after each signal, the receiving apparatus being so arranged that the reverse current will produce no sign.

Receiving Apparatus.

This is composed of—

1st. A main relay, shown by figs. 3 and 4.

2nd. Two accessary relays to which are given the name of interrupting relays, shown by fig. 5.

3rd. A "Morse" receiver shown by fig. 6.

4th. An ordinary interruptor and electric striking work not shown upon the drawing.

The small bar A, fig. 3, is of steel, tempered and magnetised; its lower pivot which terminates in a cone rests by its point only on the point of an inverted cone hollowed out of a hard stone, or in a small block of well tempered steel; the upper pivot, which likewise ends in a cone, also rests by its point only upon the point of a cone hollowed out of a small block of well tempered steel. The hard stone or the block of steel is set in the lower screw and the block of steel in the upper screw, which are placed at the end of the fork B; the base of the cones hollowed out of the hard stone and the small block of steel having a diameter equal to twice the diameter of the pivots, and a depth equal to that of the cones of these latter, the surfaces are everywhere perfectly smooth and polished, and the arching or curving of the piece is absolutely perfect; the result is that the friction of the pivots of the small bar A are almost null, and that nevertheless these pivots must forcibly always remain in the centre of the hollow cones, and that consequently the position of the small bar A never leaves that vertical line notwithstanding the evolutions which it may have to perform.

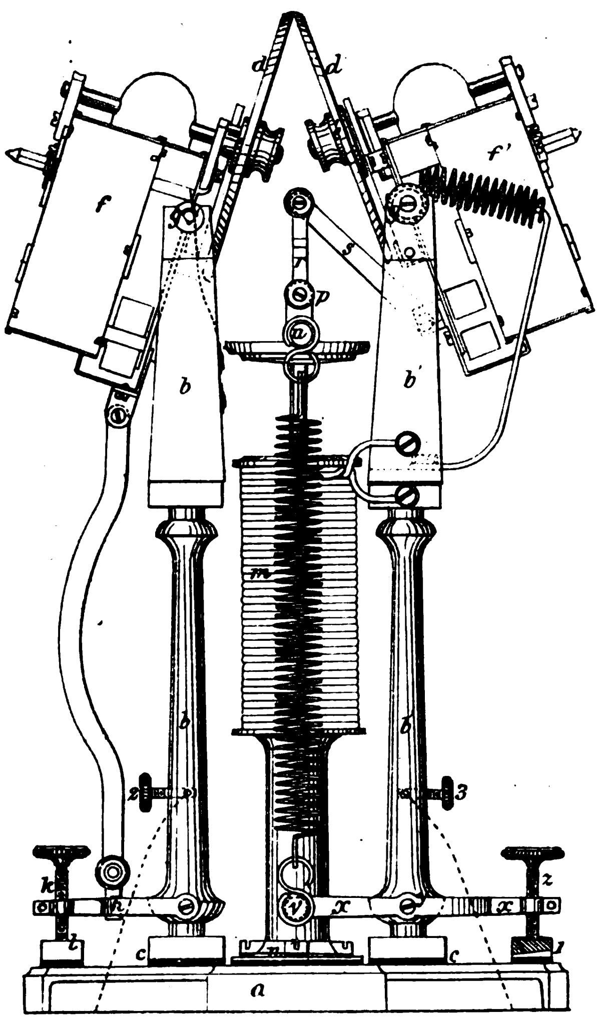
The centre of rotation of the small bar A is placed in the axis of the two poles of an electro-magnet formed by the double horse-shoe, fig. 4, around which is wound insulated copper wire, which forms the four reels C. The result is, that so long as no current passes through this wire the small bar A remains motionless, and parallel to the cheeks or flanges of the reel C either from the effect of the attraction which the two poles of the electro-magnet (which at this moment act simply as iron) exercise equally upon its two poles, or from the influence of the magnetised bar E, which compels the small bar A to keep the same direction as itself; but directly a current, however weak, circulates in the wire, the horse-shoe is immediately transformed into a magnet, and its two poles become the one positive, the other negative. The small bar A is then compelled to turn upon itself under a quintuple influence, namely—

1st. The quadruple influence which the poles of the electro-magnet exercise upon it, for its negative pole is attracted by the positive pole and repelled by the negative pole of the electro-magnet, whereas its positive pole is attracted by the negative pole and repelled by the positive pole of the aforesaid electro-magnet.

2nd. The influence which the passage of the current in the two reels, placed in front of the north pole of the small bar A, exercises upon this latter; the result is that the small bar A is so sensitive to the slightest passage of the current in the reels C that $\frac{1}{100}$ of the current of a single element "Minotto," after having traversed a resistance equal to that of a transatlantic cable, is more than sufficient to make it work. Now as the south pole (N) of the small bar A is always approaching the side of the positive pole of the electro-magnet, and as the operator or

telegraphist may at pleasure send the currents so as to transform into positive pole either the pole on the right or that to the left of the electro-magnet, the south pole of the small bar A may at the will of the operator travel either to the right or to the left, and consequently touch either the spring G, or that, F. The small bar A being in metallic contact with the fork B by the intermediary of the small block or small blocks of steel, the fork B being in connection with one of the poles of a local pile, the spring F with the electro-magnet *a* (see fig. 5), the spring G with the other electro-magnet of the other interrupting relay, which is not seen in fig. 5, and these two electro-magnets being in connection with the other pole of the same local pile, the result is, that when the south pole of the small bar A touches the spring F the armature *b* is attracted and the spring *c* touches the button or stud *d*, and when the south pole of the piece A touches the spring G the same manœuvre is produced upon the other interrupting relay. Now the knob or stud *d* being in connection with the terminal *i*, which is itself in connection with the electro-magnet H by the intermediary of a terminal (see figures 5 and 6), the spring *c* being in connection by means of the terminals *k* and *r* with one of the poles of a second local pile, and the other pole of this pile being in connection with the electro-magnet H, the result is, that at each contact between the spring *c* and the knob or stud *d* the armature K is attracted, and the spur wheel L prints a red dot upon the strip of paper.

(*To be continued.*)



THE REGNIER ELECTRIC LIGHT LAMP.

THIS ingenious form of lamp, of which we give an illustration, possesses very distinct points of novelty from those which have been previously designed. Abandoning the carbon points, M. Regnier employs two circular discs of carbon, inclined towards one another, so that the voltaic arc passes between their edges. By keeping the discs in slow but continuous rotation, fresh portions of the edges are presented

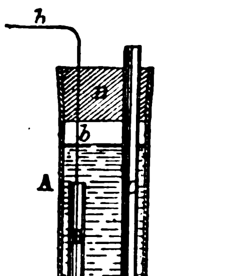
to the action of the current, and thereby the necessary equal space for the voltaic arc to traverse is preserved.

In the figure, *a* is the base of the apparatus, *b b b' b'* are forked standards, *d d'* carbon discs having a continuous rotary motion imparted to them by the clockwork motors *f* and *f'*. At *g g'* are the trunnions on which both discs and motors oscillate; *i h* is a forked lever connected to the motor *f* by a long curved rod; *k* is a button screwed on the end of this lever, and ending in the cup *l*. By means of this screw the motor *f* can be caused to move backward or forward so as to adjust the carbons. *m* is a coil of wire surrounding a soft iron magnet (not shown).

By means of the rod *p*, crank *r*, and arm *s*, this magnet by pulling downward moves the motor *f* to the rear, and determines the separation of disc *d*. At *t t* are springs which tend to move the disc *d'* in contact with the disc *d*, and so to establish the light. These springs, attached at *u* and at *v*, act on the motor *f* through the crank *r* and arm *s*. *x y z* is a forked lever attached at one end to the springs and carrying at its other extremity a set screw, by means of which the springs can be more or less extended, and the lamp thereby regulated. 2 and 3 are the terminals to which the battery wires are attached.

CHLORIDE OF SILVER CELL.

THE annexed figure represents a small form of De la Rue's chloride of silver cell, which is remarkably well adapted for electrical testing, either on shore or at sea. We have already had occasion to



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mention the special qualities in favour of this cell for such a purpose—its very constant electro-motive force from time to time, and especially during the taking of insulation resistance tests, its freedom from variation in electro-motive force when shaken or otherwise disturbed, its small portable form and cleanliness, and its comparative economy in the end. We hear that it is already coming into use as a testing battery.

In the diagram, A is a glass vessel, closed at the top to keep out dirt by a stopper of cork or solid paraffin D, but preferably of cork, because it can be handled with more ease and fits the cell more tightly than paraffin, which is apt to work loose when fitted to glass.

The negative pole C consists of a cylindrical rod of chemically pure zinc supported by the cork stopper, which is perforated to receive it. The zinc rod has a hole in the top to allow the silver connecting wire or electrode which goes to the next element to be soldered in.

The positive pole consists of a cylinder of silver chloride B, having a silver wire or electrode *b* cast into it. This chloride rod is usually enclosed in a hollow cylindrical diaphragm of fine parchment paper.

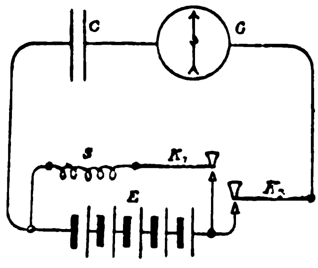
The solution for charging the cell is made by dissolving 23 grammes of pure sal-ammoniac or ammonium chloride in one litre of water.

The electromotive force of each element is about 1·10 volts, and the internal resistance is about 8 ohms. Both of these qualities are very constant.

In the action of the cell, pure silver is reduced and deposited on the floor of the cell. To prevent the short circuiting of the poles by this metallic deposit, it is best to keep the zinc rod about three-eighths of an inch raised above the floor of the cell. This pure silver deposit can be readily turned into chloride of silver again by means of a small quantity of chlorine, and it is then only necessary to melt the chloride so formed, and re-cast it into rods for use over again, otherwise the pure silver may be sold as it is. We have already pointed out in a recent number of the TELEGRAPHIC JOURNAL that twenty, fifty, or even a hundred of these cells can be fitted with solid paraffin into a small box easily carried in the hand, so as to form a convenient portable testing battery for the use of electricians abroad. For medical men employing the feeble current cure, this cell is also highly convenient.

MEASUREMENT OF THE RESISTANCE OF A BATTERY.

THE following modification of the ordinary method of testing the internal resistance of a battery by means of a condenser is said to give good results.



In the accompanying diagram, E is the battery, whose resistance is required, C is a condenser, G a galvanometer, S a shunt, and K_1 and K_2 are two keys for making contact. In making the test by the ordinary method, as is well known, the key K_1 is first depressed, and the deflection on the galvanometer due to the charging of the condenser by the whole battery current observed. The condenser is then discharged, and the battery shunted with S, and a second deflection observed on the galvanometer, namely, that due to the reduced battery current.

From these two deflections the resistance r of the battery is found by the formula,

$$r = \frac{D - D^1}{D^1} \times S,$$

where
r = resistance of battery in ohms,
S = resistance of shunt in ohms,
D = deflection obtained with battery unshunted,
D^1 = deflection obtained with battery shunted.

It is advantageous in making this test to observe D^1 as soon as possible after the shunt S has been applied to the battery, since its application changes the internal state of the battery by altering the conditions of working, especially if it be small. The best result would be obtained at the instant when the making contact with K_2 inserts the shunt. Instead of charging the condenser two separate times, however, it is only necessary to charge it once, namely, when taking the full deflection D. If while it is thus charged, the shunt S is inserted by depressing the key K_2, this has the effect of partially discharging the condenser, and causing a back throw on the galvanometer. This reverse deflection deducted from the full deflection D, should give a highly correct value for D^1, since it is due to the instantaneous application of S.

Reviews.

The Telegraph Pocket-book, Diary, and Telegraph Code for the year 1878. Edited by Lieut.-Col. FRANK BOLTON, Hon. Sec. Tel. Eng., and JAMES SIVEWRIGHT, M.A., Superintendent British Postal Telegraph Service. Letts, Son, & Co., London.

THIS handy little volume, which has lately been issued, is likely to prove very useful, containing as it does, a large amount of judiciously selected matter relating to both the scientific and commercial branches of telegraphy.

Commencing with a selection of formulæ which are likely to be useful to the practical electrician and telegraph engineer, and amongst which we notice a valuable estimate for the quantities of materials and cost of labour required in erecting an overground and underground line, there follow several pages of diagrams, showing the connections and methods of joining up the various telegraph instruments in use. These will prove very useful for inspectors who have charge of the various kinds of apparatus, and who, although gifted with good memories, may, at times, be at fault when making changes in some of the more complicated systems.

An epitome of electrical, magnetic, and telegraphic history, dating from B.C. 600, shows well the progress of the science.

The British Telegraph system naturally comes in for a fair share of notice, and several pages are devoted to useful matter, having reference chiefly to the regulations concerning the despatch and receipt of telegrams, the tariffs for the same, and for the renting of private wires, the distribution of time signals, etc.

We notice from the diary that in France there are four kinds of telegraph offices, viz., offices worked by the Telegraph Department, Municipal Offices, Semaphore Stations, and Lock and Weir Stations. The latter are for the purpose of working the boat service, and giving timely notice of the approach of floods.

Full particulars are given of the boards of management of the various submarine telegraph companies, together with the lengths of the various sections of cable owned by them; the tariffs are also clearly indicated.

A telegraph code, which completes the telegraphic matter, forms one of the most useful features of the book, and will be particularly useful to those who have to transact much business by the aid of the telegraph. The code is so arranged that many sentences in common use in the English language can be expressed by a single word, and it has been prepared for one thousand such words and sentences, many of which will, of themselves, form complete messages of a frequently recurring description.

Following a description of signalling with flashing signals, comes a list of telegraph engineers and contractors, and then seven pages of Messrs. Letts' publications, from "The Family Washing Book" to "The Angler's Register." The appropriateness of the introduction of this catalogue is not, at first, very apparent, but upon reflection, it seems to dawn upon us. No doubt Messrs. Letts mean to suggest that the Atlantic, or, indeed, any other sea, may be regarded as if it were a washing-tub into which our submarine cables have been thrown, and that, as a check upon the carelessness and dishonesty of old Tethys Oceanus' "Missus," it is prudent to keep an inventory of what we have thus entrusted to her to soak, just as we do of the linen which we send every week to the laundress. And then "The Angler's Register" will be found convenient for entering what cables have been grappled for and fished up from time to time, whether whole or in fragments. It seems a pity that "The Angler's Guide," or "The Complete Angler," is not also included in the catalogue. That might have given us information as to the best baits, ground and bottom, for catching lost lengths, and even have recommended killing flies for every month in the year, which would save a world of trouble and expense by "rising" such lengths or ends to the surface, where they might be netted or gaffed according to size and weight.

Des Paratonnerres à pointes, à conducteurs et à raccordements terrestres multiples. Par MELSENS, Membre de l'Académie Royal des Sciences de Belgique. F. Hayez, Bruxelles.

THE object for which this work is written, is the description of the system of lightning conductors established on the Brussels Town Hall. Curiously enough, there is no record of any damage having been done to the building by lightning previous to the ninteenth century, though since that period injury has been done on several occasions, and notably in 1860 and 1863.

The conductors on the edifice appear to have been erected in a most substantial and scientific manner, and the diagrams in the book show well how the work has been executed.

Apart from being a descriptive volume, the book is very useful, as it brings together the opinions on the general subject of a number of eminent authorities.

Notes.

AT the general meeting of the Society of Telegraph Engineers, on the evening of Wednesday, January 23, the splendid electric light, of 1,200 candles intensity, produced by a magneto-electric machine of Messrs. Siemens, commanded the admiration of all. The light from the glowing carbon points was reflected upwards upon a screen of white linen suspended from the roof, and thence reflected down again upon the auditory. It was curious to observe the fleecy whiteness of the screen when the light played upon it, a diffused whiteness resembling that of a sunlit cloud, or the surface of new-fallen snow; and we can recommend it as a theatrical effect or as a source of diffused light in photography. Besides the electric light, a bichromate cell, invented by Dr. Burns, an American, and yielding a current whose strength is extraordinarily increased by pumping air into the liquid by a hand syringe, was exhibited, as also a piece of Edison phonograph slip, with recorded speech upon it. The slip was of tin-foil, and covered with minute indentations. The address of the President, Dr. Siemens, was listened to with marked attention; but it was rather to be regretted that some notable advances in telegraphy were left unnoticed, such as the duplexing of ocean cables by Muirhead's Artificial Line, and the working of cables by means of Thomson and Jenkin's Curb Sender.

THE announcement of the resignation by Mr. W. Langdon, of the office of Acting Secretary to the Society of Telegraph Engineers, will be received with very great regret by all connected with the Society. It will be extremely difficult to find a successor who will prove such an energetic and efficient secretary as Mr. Langdon has been.

NEW ELECTRICAL LAW.—Clausins announces the following general law, of which many of the known laws of electrical reciprocity are immediate consequences. Suppose there to be any number of conductors c_1, c_2, c_3, etc., which mutually influence each other; let them receive two different charges of electricity. At the first charge, let the respective quantities in the different bodies be Q_1, Q_2, Q_3, etc., and the resulting potentials V_1, V_2, V_3, etc. At the second charge let the corresponding values be Q_1', Q_2', Q_3', etc., and V_1', V_2', V_3', etc., then we shall find $V_1 Q_1' + V_2 Q_2' + V_3 Q_3' +$ etc., $= V_1' Q_1 + V_2' Q_2 + V_3' Q_3 +$ etc., or taking the sums, $\Sigma V Q' = \Sigma V' Q$.—*Annalen d. Phy. u. Chim.*

THE French postal and telegraph services are to be united and placed under the directorship of M. Cocheris, a well-known writer on political economy.

THE TELEPHONE AT OSBORNE.—On the evening of Monday, January 14th, Professor Graham Bell had the honour of exhibiting to the Queen the marvellous capabilities of the telephone. The trial took place in the Council Chamber of Osborne House, Isle of Wight, in presence of Her Majesty, the Princess Beatrice, the Duke of Connaught, and others of the Court. A temporary line three-quarters of a mile long had been erected between Osborne House and Osborne Cottage, the residence of Sir Thomas Biddulph, and the experiments began by the Princess Beatrice speaking with Lady Biddulph. At Osborne Cottage Miss Kate Field, the well known vocalist, sang "Kathleen Mavourneen," "Coming through the Rye," and the "Cuckoo Song," then recited the epilogue of *As you like It*, all of which were distinctly heard by the Royal party, and so well appreciated that the Queen thanked the singer personally through the telephone. Communication was then established with Cowes, where Major Webber, R.E., was superintending. Here several part songs were sung by a quartet, and plainly heard at Osborne. At Southampton, which was switched in circuit somewhat later by Mr. W. H. Preece, a bugle call sounding the "Retreat," fell on the hushed ears of the assembly in the Council Chamber like a distant echo, and produced a stirring impression. It is remarkable that, whereas for ordinary speech or music the ear requires to be close to the telephone in order to hear anything at all, the bugle note was heard by everyone present, though standing several yards from the receiving telephone. At the conclusion of the experiments, London was connected up to Osborne, and tunes played on Mr. Bell's telephonic organ in London were plainly heard by the Royal party. The experiments lasted from half-past nine to twelve o'clock. The arrangements at Osborne were made by Messrs. Ormiston and Chevallier, of the Silvertown Telegraph Company. On the following day, some further trials were made in presence of the Royal household, and several of her Majesty's ministers.

TELEPHONE-IANA—A MAKESHIFT TELEPHONE.—In a recent lecture at the London Institution, Professor Barrett mentioned that a cheap, makeshift telephone could be made from an empty tooth-box, by making a hole in the bottom, about the size of a half-a-crown, and fixing over it a disk of sheet iron (such as can be cut from the lid of a meat-tin) by means of the cover of the box. A small bar magnet having an ordinary thread reel wound with insulated wire stuck on one pole, completed the necessary parts of the contrivance. Professor Barrett stated that with telephones made in this way he had been able to converse over a distance of 100 yards.

A TELEPHONE WITH SEVERAL AUDITORS.—Professor John McKendrick, writing from the Physiological Laboratory, Glasgow University, to *Nature*, says that "in endeavouring to utilize one telephone by making several friends listen at once, I have found that by fixing the metal disc to a thin membrane over a small cavity, filled with air, like Kœnig's capsule, and having a number of flexible tubes connected with it, an ear placed at the end of each tube will hear distinctly.

No less than eleven different patents for telephonic apparatus were taken out in England from November 20 last year to January 15th. Among the patentees we observe the names of Professor Graham Bell, Professor Fleming Jenkin, and also Dr. E. W. Siemens. One of the patents (Mr. Pritchett's) relates also to phonographic apparatus.

THE TELEPHONE AND "ELECTRIC PEN" IN RUSSIA.—M. Sergins Kern reports in the *Chemical News* that the telephone is also the great novelty of the day in Russia, where several firms are selling them at £1 a-piece, a price which is considered there to be too high. We wonder what the Russians would think of the price charged in England—£25 and £35 a pair. M. Kern also states that the diffusion of Edison's electric pen is much checked by Government regulations, as the use of printing implements for private study is strictly forbidden in Russia.

AT a recent meeting of the Medical and Physical Society of Würzburg, Professor Fick showed a curious effect of the articulating telephone currents on the prepared limb of a frog. The two terminal wires of a telephone were placed in contact with the leg muscles of the frog, and on speaking into the instrument the limb was seen to twitch itself. The vowel sounds *a e i* had scarcely any "ranëic" effect; whilst *o*, and especially *u*, on the other hand, produced a most violent convulsion. The command "Liege still," in a loud voice, had hardly any effect; whereas the word "Tucker," even in a low tone, caused the limb to jerk forcibly. These experiments serve to remind us of the original observation of Galvani, and the remarkable progress of electrical science since his day.

HUGHES' APPARATUS.—M. Christiani, telegraph secretary in Berlin, from a consideration of the Bell telephone, has been led to employ the magneto-induction currents of a Hughes' Apparatus to put a second Hughes' at a distance into action. He found it possible to work with certainty through 120 kilometres of cable.

AN interesting note on Edison's telephone has been communicated to the Academy of Sciences, Paris, by M. Bréguet, on behalf of MM. Garnier and Pollard, engineers of naval construction Cherbourg. Wishing to realise the effect of Edison's plumbago telephone, these experimenters took a little plate of sheet-iron like the disc of Bell's telephone, and pointed against it the end of a pencil of plumbago, so that the pencil point pressed lightly on the centre of the plate. The pencil on the one hand, and the plate on the other, were connected to the two terminals of an ordinary Bell telephone, in which a bar of soft iron took the place of the magnet. A battery of ten Leclanché elements was inserted in the circuit. On speaking so as to throw the plate into vibration the end of the plumbago style underwent a series of changes of pressure from the plate without the contact being broken between them. These variations of pressure were attended by corresponding variations of resistance in the pencil, and consequently by modulation in the current in the circuit. These current changes in turn caused the disc of the Bell telephone to vibrate and give out the sounds spoken beside the transmitting plate. This union of Bell's and Edison's telephones may lead to louder utterances on the part of the former.

MR. EDISON has invented a larger speaking phonograph, which is capable of being heard at a distance of 175 feet.

JABLOCHKOFF'S ELECTRIC CANDLE.—From recent experiments with this electric wick, it appears that its cost as compared with the ordinary carbon sticks stands greatly in its way as a rival of the latter. A candle 0·12 metre long burns half an hour, giving out a light equivalent to 250 candles, and costs 50 centimes. A light equivalent to 1,000 candles, lasting an hour, would therefore cost 4 francs for the wick alone, apart from the cost of working the magneto-electric machine. With the ordinary carbon points and regulator, the same light can be maintained at a cost of only 2½ centimes, from the consumption of about one-tenth of a metre of the points.

ALUMINIUM IN TELEGRAPHY.—The *D. Allg. Poly. Zeitung* draws attention to the fact that aluminium has double the conducting power of iron, and being also tough can be made into very slender wires. Owing to its extreme lightness, line wires of aluminium would be especially suitable for military telegraphy service; great lengths could be easily transported. The difficulty of producing it in quantity is against its application for the purpose in question; but it is thought that the mineral oryolite, which is abundant in Greenland, would furnish plenty of the raw ore from which the metal might be reduced by smelting. An alloy of aluminium and iron might become useful as a material for telegraph wires.

IT is not, we think, generally known that aluminium is highly magnetic, as well as a good conductor. In telegraphic apparatus having movable coils, actuated by the passage of a current, aluminium from its lightness and good conductivity, would seem to be eminently fitted, and we believe that it has already been applied by Messrs. Siemens, Berlin, as the wire for the coil of their new recorder.

ELECTRO-GILDING BY MEANS OF FERRO-CYANIDE.—*Dingler's Polytechnischer Journal* gives the following process of Herr Ebermayer for electro-gilding. The bath is prepared by making a solution of 300 grammes of ferro-cyanide, 100 grammes of carbonate of potash, and 50 grammes of sal-ammoniac, in 4 litres of water. To this solution are added 200 cubic centimetres of a

second solution, formed by dissolving 100 grammes of gold in aqua-regia, driving off the excess of acid and dissolving the chloride of gold so formed in water, so as to make up a litre. The mixture of the first and second solutions takes a blue colour, which disappears on boiling, whilst ferric oxide is precipitated. The liquid when cooled, filtered and made up to 5 litres is the gilding bath. As it is a bad conductor and deposits ferric oxide upon the electrodes, a small quantity of cyanide, not sufficient to evolve hydrocyanic acid on boiling, is added. The gilding is done, performed at a temperature of 40° to 50° C. When the bath ceases to yield a good deposit, another 200 cubic centimetres are added as before, until all the gold is used up. If the bath is to be employed for further quantities of gold, one-tenth of the quantities of salt above prescribed must be added to the bath. The advantage of the above process lies in avoiding the use of large quantities of cyanide of potassium, which is objectionable on sanitary grounds.

A CONSTANT DANIELL CELL.—In the *Philosophical Magazine* for January, Dr. Oliver J. Lodge describes a form of Daniell cell, without a porous partition, in which diffusion of the sulphate of copper and sulphate of zinc solutions is so retarded as to keep the cell practically constant in electro-motive force. The plan consists in enclosing strips of the two metals, zinc and copper, each in its own separate test tube, and immersing the two tubes lashed together by silk thread into a vessel containing a solution of sulphate of zinc. The tube into which the copper strip dips, though open at the top, is closed at the bottom, so that the sulphate of zinc solution only gains access to it by the top. On the other hand the tube enclosing the zinc strip is open at the bottom, so that the sulphate of zinc only gets into it there. A few crystals of sulphate of copper lie at the bottom of the copper tube and dissolve there. The ends of the metal strips are carried up outside the external vessel to form the poles of the cell. The special advantage in this arrangement consists in the fact, that in order for the sulphate of copper solution to make its way to the zinc plate it must diffuse up out of the copper tube, and downwards through the sulphate of zinc solution, then upwards through the zinc test tube. The resistance of such a cell is, however, very high. The tubes can be arranged so that no diffusion at all takes place by raising the copper tube up so that its edge, which should be damp, is about one quarter inch above the surface of the zinc solution in the vessel. The electrical connection is maintained by the moisture, or film of zinc salt, on the glass surface of the top edge of the tube, while diffusion is prevented. The only change which can go on in such a cell is the concentration of the zinc solution, and that can be kept in check by drawing off the solution with a pipette, and replacing it by fresh water from time to time. Dr. Lodge proposes the latter form of cell as a standard of electromotive force.

WHEATSTONE'S VIOLINCELLO.—In a letter to the *Athenæum* on the "Origin of the Telephone," Mr. William Chappell relates an amusing anecdote in connection with Wheatstone's early researches on the transmission of sound. "One of Wheatstone's earliest discoveries," says Mr. Chappell, "(one long before his electric telegraph), was that all the varying sounds of musical instruments might be conveyed to considerable distances by means of solid rods joined together. It was only necessary to bring the end of the topmost rod sufficiently near to the instrument to receive its vibrations without touching it. An eminent foreign musician, a violincello player, coming to England, brought a letter of introduction to Wheatstone. He left the letter at his house and appointed to call again at a particular hour on the following day. Wheatstone was at home to receive him, and, thinking to surprise and to amuse his visitor, he hung a violincello on the wall of the passage, having a rod behind it to connect it with another which was to be played from within when he entered the hall. Wheatstone told me that his guest turned in every direction to find whence the sound came, and, at last, approaching the violincello hanging on the wall, and having satisfied himself that they proceeded from it, although there was neither hand nor bow to play upon it, he rushed out of the house in affright, and would never enter it again."

A GERMAN paper gives a detailed description of the apparatus designed by Captain Buchholtz, of the Prussian railway regiment, and recently adopted in the German army, for providing telegraphic communication between the different fractions of an outpost line, or between the outposts and the main body of an army in the field. The whole apparatus consists of two small Morse's receiving instruments, a Siemens' and Halske battery, and a cable about three millemetres in diameter. It being impossible with a movable apparatus to use the earth to complete the electric circuit, a return wire is provided in the cable. An ingenious but extremely simple arrangement has also been devised for joining lengths of the cable together; the operation being rendered so simple that it can be performed by any one without any previous instruction or practice. The cable itself is manufactured in lengths of 500 metres, each being carried on a reel, which fits into a havresack in such a way that, as the man carrying it walks forward the wire unrolls itself behind him. The cable can therefore be laid as quickly as a man can walk. The receiving instrument is fitted in a small box, on the outside of which is the sending key and a bell. The weight of the box, which also contains a small galvanometer, is about 8 lb., and it can be carried in front of a man by means of a strap across the shoulder. The battery is carried in another box, and consists of ten elements, the whole weighing about 22 lb. It will act for months without the materials being renewed, all that is necessary to keep it in order being to add to it occasionally a few crystals of sulphate of copper and

a little water. The whole apparatus is to be carried in time of war on one of the waggons accompanying the battalions of infantry, and, when required for use, will be given to the men who are to employ it in exchange for their packs.

Patents.

4855. "Improvements in transmitting, receiving, and printing telegraphic messages, and in the apparatus employed therein, or connected therewith."—F. J. BOLTON, Dec. 24, 1877.

4903. "Magneto-electric machines"—W. R. LAKE (communicated by E. Weston), Dec. 27, 1877.

4934. "Improvements in electric telephony, and in telephonic apparatus."—C. W. HARRISON, Dec. 29, 1877.

58. "Electric telephones or apparatus for transmitting sounds."—G. STEPHENSON, Jan. 4, 1878.

125. "Improvements in and appertaining to telegraph alarm apparatus (to be known as the telmoreal)."—W. P. THOMSON (communicated by S. Mohr), Jan 10, 1878.

131. "Improvements in the construction of electrical cables, so as to protect the cores of such cables from the destructive action of marine and subterranean insects."—D. GÖLLNER, Jan. 10, 1878.

143. "Improvements in signal lights, to be used for military or other purposes."—R. N. COURTENAY, Jan. 11, 1878.

160. "Improvements in transmitting signals on board ship and in other vessels or situations and in apparatus therefor."—T. BASSNETT, Jan 12, 1878.

162. "Improvements in and relating to the production of magneto-electricity and the application of the same to telephonic or telegraphic purposes and in apparatus therefor (complete)."—W. R. LAKE (communicated by J. Mc. Tighe) Jan. 12, 1878.

191. "New or improved means and apparatus or appliances for utilising and conveying sounds or signals from or to telephonic or phonographic sound producing or signalling instruments."—G. E. PRITCHETT, Jan. 15, 1878.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

76. "Improvements in the insulating supports of telegraph wires."—JOHN CRISP FULLER and GEORGE FULLER, dated Jan. 8, 1877. 6d. This invention is fully described in the *Telegraphic Journal*, No. 118.

118. "Improvements in electric telegraph apparatus delivering printed messages."—JAMES WYARD GOOCH, dated Jan. 10, 1877. 6d. This relates to a type printing telegraph apparatus in which the sending and receiving instruments are rendered synchronous in their action by clockwork; also an arrangement whereby several receiving instruments may receive independently of each other when connected to the clockwork of one sending instrument.

121. "Improved means for lighting gas."—PIERRE DRONIER, dated Jan. 10, 1877. 6d. This consists in lighting gas by bringing it into contact with a platinum wire heated red hot by electricity. Provisionally protected only.

127. "Improvements in the means and apparatus for telegraphing; applicable also for registering or recording electrical action."—SIR JAMES ANDERSON, HENRY NICHOLSON, BLACKWOOD-PRICE, and HENRY GEORGE CHEESEMAN, dated Jan. 10, 1877. 6d. Recording telegraphic signals by the movement of a ray of light or sensitised paper. Provisionally protected only.

160. "A new electric automatic indicator for electric bells, for house telegraphy, and other purposes."—THEOPHILUS COAD, dated Jan 12, 1877. This consists in fixing a regulator to the armature of the bell indicator, so as to give the armature a longer or shorter period of oscillation. *(Not proceeded with.)*

197. "Improvement in multiplex telegraphs."—A communication from G. B. PRESCOTT, U.S., dated Jan. 15, 1877. 1s. This consists in a full description of Messrs. Prescott and Edison's quadruplex system.

270. "Improvements in apparatus for generating electricity."—CROMWELL F. VARLEY, dated Jan. 10, 1877. 8d. This invention has for its object the production of electricity, by which electrostatic discharges and dynamic currents of sufficient potential to generate ozone, produce chemical decomposition, the electric light, and other electrical effects, can be obtained and maintained when desired, as in the production of the electric light. It consists of a magneto-electric machine for generating currents, and an improvement on the author's machine (described in Patent No. 206, 1860), by which accumulating charges are stored upon inductive surfaces and on rotatory dielectrics so as to enable sparks of considerable length to be obtained. These sparks are employed in the electric light to re-establish the circuit between the carbon points when accidentally or momentarily interrupted. The magneto-electric machine and electrostatic multiplier are employed together in producing the electric light. The machine gives rise to an electric arc between the carbon points, and the multiplier renders it constant by placing its poles close to the carbon holders so that a stream of sparks may pass to them constantly so long as the light is being maintained. The high tension electricity, which in this manner is caused to pass between the carbon points, maintains the magneto-electric discharge.

302. "Improvements in galvanising and metal coating apparatus."—JOHN LYSAGHT, January 24, 1877. 6d. This consists in forming the pots with flues passing through them so as the better to maintain uniform temperature in the molten zinc used for galvanising. Other improvements consist in forming the pots with a channel at the bottom within which the furnace is constructed, to the rollers employed in the manufacture of galvanised iron, and to the insertion of movable receptacles, for hard spelter or other deposits, into the bottom of the pots.

374. "Improvements in transmitting and telegraphic messages, and in apparatus therefor, and also in type-writing processes and in apparatus therefor."—SAMUEL PHILLIPS, Jan. 29, 1877. 6d. This consists in a means for transmitting words as fast as they can be uttered, and recording them in a multiple form if required, at both ends of the line in Roman type, as printed, and also in a means whereby short-hand characters traced at either end of the wire are instantly translated into Roman printed letters. Both results are produced by a set of electro-magnets corresponding to the letters of the alphabet actuating type so as to print. The mechanism is synchronous at both ends of the line. Simple movements in manipulating, such as are necessary in making short-hand characters, can be translated by the mechanism into printed letters.

421. "Improvements in electric logs for measuring the speed of vessels."—J. P. Haines, U.S., Jan. 31, 1877. 6d. This consists in the employment of a flexible diaphragm of india-rubber to separate the chamber containing the terminal wires of the circuit from the chamber containing the mechanism of the log, so as to exclude water from the terminal chamber. A lever arrangement actuated by the vane of the log pushes a rod, which passes through the india-rubber diaphragm against the terminal wires so as to cause them to make contact as each unit of distance is traversed by the ship. The contact establishes a current indicating circuit between the log and the ship, and the distance made is recorded on board.

Correspondence.

To the Editor of The Telegraphic Journal.

Sir,—In your No. 110, Mr. Thomas T. P. Bruce Warren says as follows:—

* * * * * *

"The cables and core made by Mr. Hooper for the India Government are considered monuments of success, for we must not overlook the important fact that experience had to be gained in the manufacture of india-rubber cores as with gutta-percha, and yet where decided and continued failures had to be recorded with the earlier gutta-percha cables, the very first length of india-rubber cable manufactured continues to work to this day. It is but fair to point out that the faults which were heard of some time since in the Persian Gulf india-rubber cable were not in any way due to a failure of the material. I do not hear such good accounts of the india-rubber cable laid between Ceylon and the mainland of India. This piece, I understand, is very much lower in insulation than when manufactured—in fact its dielectric resistance is expressed by saying that it still works! I am, however, not able to confirm what has been said with respect to certain individual faults cut from this cable, although I believe them to arise from avoidable causes.

"Now we must measure these facts not only as against our present knowledge of what has been done, or what india-rubber is capable of being brought to, but with the fact that attempts were made twice to maintain communication between Ceylon and the mainland by means of gutta-percha, both of which resulted in failure in about as many months as may be counted in years with the india-rubber core."

* * * * * *

It is quite true that the insulation of the india-rubber cable between Ceylon and India is very low. See the following table:—

	Insulation resistance, per knot. megohms.
When laid January, 1867	7,000
September, 1871 (next test)	22·9
December, 1876 ... ... about	0·4

However, I do not know what Mr. Warren means by "certain individual faults cut from this cable," because the cable has never been cut or touched since it was laid, and all the tests which have been taken shew that the cable has deteriorated throughout, and that there are no special faults in it.

Only *one* attempt was made to maintain communication between Ceylon and India by means of gutta-percha, viz., by the cable laid in 1857, and this was so far successful that the cable worked without a single interruption not only a few months but until 1866, about 10 years, when it failed. Its failure was the cause of the india-rubber cable, above named, being laid, which has lasted 11 years (i.e., one more year than the gutta-percha cable) but is likely to fail any day. The failure of the gutta-percha cable was probably not due to any fault of the gutta-percha, but to its great mechanical unfitness for the place in which it was laid. All enquiry and examination have tended to shew the gutta-percha was not in fault. Yours truly,

W. REES PHILIPPS,
Assistant-Superintendent
Telegraphs.

Madras, 7th November, 1877.

To the Editor of The Telegraphic Journal.

Sir,—My attention has been called to a note in your number for December 15, commenting on some article which your contributor ascribes to my pen. As his remarks are somewhat petulant, not to say peevish in tone, it would have been well if he had in the first instance assured himself that I really was the author of the article in question. As I have never written any article on the "New and wonderful Phonograph" in a public newspaper, your contributor who discourses so glibly about the mistakes of others, must in this instance have made a slight mistake himself. Neither have I written in the *Nineteenth Century* as he states; nor, again, has the "Manufacture of Soap" been made a subject for my pen. The note further refers to some former diatribe of his on a remark of mine, about a possible extension of the powers of the telephone. He should know, however, that that remark was based on a statement of Sir W. Thomson's, who although not a professional electrician, has been able as a scientific electrician to show professionals the possibility of several things they had deemed absurdly impracticable.

I presume your contributor's objection to the passage he wrongly attributes to me is based on the use of the fanciful words "crystallization of sound," because, so far as the possibility of obtaining a material record of sound is concerned, there is no longer any room for doubt or question.

An essay on Mr. Edison's invention recently appeared in the *Spectator*, to which I sometimes contribute. It is not mine, however. Let me add that no unsigned articles appearing in any journal where a writer *can* append his name, come from my pen.

Faithfully yours,
RICHARD A. PROCTER.

To the Editor of The Telegraphic Journal.

Sir,—I have a weakness, and that is a dislike to seeing my inventive chicks fathered on someone else.

A little matter that I worked out in Italy some two years ago, and which, since I published the method in the *British Journal of Photography*, has come largely into use, is described under an article on Photography in your issue of December 1, as part of a "New System of Photography" introduced by Messrs. Wratten and Company.

The parts marked* in the enclosed are those described first by myself, as I have stated; and I think you will see the justice of my remarks. Yours truly,

WALTER B. WOODBURY.

South Norwood, S.E.
January 14, 1878.

* "The film can then be removed to a piece of prepared paper, and, when dry, stored in a book until the traveller's return home, when with great ease it may be again superimposed on glass for printing. This method of removing each day's negatives from the glass to paper presents two advantages: firstly, the negatives can be safely carried, and in a light bulk; and secondly, six pieces of glass will serve for the production of an indefinite number of negatives."

Telephone.—Descriptions of the various kinds of telephones are contained in Nos. 69, 79, 97, 102, 108, 109, 110, 111, 115, 116, 117, 118, of The Telegraphic Journal—[Ed. Tel. Jour.]

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

The opening meeting of this society for the present year, was held at the Institute of Civil Engineers, 25, Great George St., Westminster, on the evening of Wednesday the 23rd ult.

The chair, at the opening of the meeting, was taken by the retiring President, Professor Abel, F.R.S., who introduced the new President, Dr. C. W. Siemens, F.R.S., D.C.L.

The minutes of the previous meeting having been read and confirmed, the Secretary read a list of new candidates for election into the society.

The President then rose to deliver his inaugural address of which the following is a summary:—

The President commenced by remarking that when he delivered his first address, six years ago, the society was composed of only 110 members of every description. This number has now reached up to nearly 1,000 members.

The six volumes of transactions issued by the society since its origin are proof of its activity as a scientific institution, whilst its status has been much advanced through the establishment of a valuable scientific library, bequeathed in trust by the late Sir Francis Ronalds.

The subject of Duplex Telegraphy and the progress it had made under C. A. Nyström of Öreboro, Sweden, Dr. Gintl of Vienna, Frischen, Dr. Werner Siemens, Mr. Stearns of Boston, and Mr. Louis Schwendler was first noticed.

The quadruplex telegraph, which may be considered to have been theoretically introduced by Dr. Stark, of Vienna, in 1855, and contemporaneously by Dr. Boscha of Leyden, and which has been developed by Mr. Edison of New Jersey, U.S., was next drawn attention to, and the possibility of further combinations of the same nature, for six or eight pairs of instruments, pointed out. The success of these improved methods of transmission depends almost entirely upon the perfect insulation and undisturbed condition of the line-wire, a subject which has yet to receive much attention on the part of the telegraph engineer.

Attention is next drawn to the great novelty of the day, the Telephone.

This remarkable instrument owes its origin to the labours of several inventors.

In the year 1859 the late Sir Charles Wheatstone devised an arrangement by which the sounds of a reed or tuning-fork, or a combination of them, could be conveyed to a distance by means of an electric circuit, including at both stations a powerful electro-magnet. In striking any one of the tuning-forks differential currents were set up which caused the vibration of the corresponding tuning-fork at the distant station, and thus communicated the original sound. In 1862 Reiss enlarged upon this ingenious suggestion in attempting to convey the varying vibrations of a diaphragm agitated by atmospheric sound-waves.

This instrument transmitted currents only of equal intensity, and was quite incapable of transmitting the human voice.

These defects in the instrument of Reiss have been remedied by Mr. Edison, who, by establishing contacts through the medium of powdered plumbago, has succeeded in transmitting galvanic currents varying in intensity with the amount of vibration of the diaphragm.

As another step towards the accomplishment of the perfect transmission of sound, may be mentioned also the logograph, or recorder of the human voice, which Mr. William Henry Barlow, F.R.S., a member of the society, communicated in a paper to the Royal Society, on the 23rd February, 1874.

In adding a contact arrangement to the recording pencil of Mr. Barlow's instrument, the message could obviously be transmitted to a distance to be recorded there either by graphical or audible signals.

The beautifully simple instrument of Professor Graham Bell, of Cambridge, U.S., must be regarded as a vast step in advance of all previous attempts in the same direction. In making the diaphragm of iron, and having recourse to Faraday's great discovery of magneto-induction, Mr. Bell has been able to dispense with the complication of electrical contacts and batteries, and to cause the vibrations of the diaphragm imparted by the voice to be accurately represented in strength and duration by electrical currents.

The currents transmitted are so minute as to escape observation by the most delicate galvanometer, as the magnetic needle, however light, must be too sluggish to be moved visibly by such quick impulses, and it requires an electro-dynamometer of exceeding sensitiveness to bring them into evidence. Mr. Köntgen concludes from experiments he has made with a high pitched tuning-fork that not less than 24,000 currents can be transmitted in one second. We here detect a rapidity of electrical transmission far exceeding our most sanguine expectations in endeavouring to increase the rate of transmission of telegraph instruments by mechanical means, thus opening out a new field for the inventive faculties of the telegraph engineer.

The telephone is no doubt capable of great improvement, which should chiefly be directed towards increasing the relative amount of vibration of the receiving diaphragm.

Improvements will doubtless be directed also towards the accomplishment of simple methods of recording the audible messages received, which has already been attempted by Mr. Edison.

Considering the minuteness of the electrical impulses and their high electro-motive force, it seems probable that they will be capable of being transmitted to very great distances through conductors of comparatively small dimensions, provided only that those conductors are not subjected to the disturbing influence by induction of currents flowing through adjoining wires.

The system of suspended line-wire now generally in use is open to many grave objections. The remedy for these is undoubtedly the underground line-wire system. This was first tried in Germany upon an extended scale in 1848-49, but was given up in favour of the suspended line in consequence of the want of experience in manufacture and imperfect protection afforded to the gutta-percha covered copper wire. Since then it has been largely used in this country for underground communication in cities, also for aerial lines, by suspending a bunch of the insulated conductors by steel wires in the air, as we see them supported on the house-tops of this metropolis.

In Germany underground cables of an aggregate distance of 600 miles have been laid, while further extensions are in course of execution. These cables consist of seven separate conductors, each insulated with gutta-percha, surrounded with a complete iron sheathing and a double outer covering consisting of hemp steeped in asphalte, producing altogether a

flexible cable of 1¼ inches outer diameter, which is laid along railways or roads at a depth of about 3 ft. below the ground.

In submarine telegraphy no startling feat of novelty can be reported, although steady progress has recently been made in improving the manufacture of the insulated conductor, in the attainment of an increased rate of transmission through long distances, in the outer protection given to the insulated conductor, and in the vessels and other appliances employed for submerging and repairing deep-sea cables.

The careful selection of the insulating material employed has also an important influence upon the rate of transmission through long cables, as it is found that different kinds of gutta-percha behave very differently in this respect. India-rubber has, it is well known, considerably less inductive capacity than gutta-percha, and appears on this account the preferable material, but its application to the conductor, without the risk of faults and of gradual changes in the condition of the material, is beset with considerable practical difficulty which has as yet limited its application. Compounds of india-rubber and gutta-percha, with other materials such as shellac, paraffin, and bitumen, have been proposed from time to time with promising results, but it has been impossible hitherto to give to such compounds all the properties necessary in the dielectric substance covering the conductor, viz., a low inductive capacity and high insulation, coupled with considerable toughness and permanency at all ordinary temperatures, and the requisite plasticity at higher temperatures. The supply of gutta-percha has hitherto been sufficient for the demand, but a large extension in the use of insulated conductors both by sea and land will, it may be apprehended, outrun the supply, and it is well on this account that we should steadily fix our attention upon such compounds as are likely to furnish a suitable substitute.

Regarding a continued supply of gutta-percha and india-rubber it is satisfactory to observe that the Indian Government have turned their attention seriously to the question of making plantations of trees bearing these gums, chiefly in the Malay Peninsula, under the able direction of Sir Joseph Hooker, and of Dr. Brandes, the Director of the Forest Department in India.

The outer covering now generally applied to shallow-sea cables consists of a sheathing of iron wire covered with a double layer of hemp steeped in asphalte, and applied to the cable in a heated condition, and this, if properly carried out, affords very efficient protection for the iron sheathing against corrosion.

In the construction of deep-sea cables, steel wires are generally used, each wire being covered in the first instance with jute with a view to reduce the weight of the cable. This construction affords the advantage of lightness combined with strength, but is objectionable, inasmuch as it affords no complete metallic sheath against the inroads of the Teredo and Xylophaga to the core, and, in the case of a cable having to be raised from considerable depths, it is apt to untwist, and run itself into kinks at the bottom.

The use of a light cable for deep seas has been ably advocated by some electricians, and its adoption has the one great argument in its favour, that its first cost is much below that of a strong cable; on the other hand the risk incurred in successfully submerging such a cable is much greater, and in the case of a fault appearing in deep water it will be hopeless to bring the light cable to the surface for the purpose of repair. It is possible that the manufacture of cables will be made a matter of such absolute certainty that the case of faults making their appearance in submerged cables may be left entirely out of consideration, but in the meantime telegraph companies have given the preference, and wisely so, to a cable which though more costly than its light competitor affords a greater security to their property in case of an accident or a fault.

But little discussion has as yet taken place of the best means for effecting the repair of cables after submersion. The important primary condition towards effecting the repair of a submerged cable is that its general insulation should be perfect, without which it would be impossible to determine the position of a break or fault with any degree of accuracy. Another important condition is the possession of a cable-ship furnished with special facilities for manœuvring, which the vessels ordinarily employed do not possess.

The transmission of telegraphic messages through long submarine cables is a subject which was at one time involved in great practical difficulty owing to the retardation by lateral induction experienced by the electrical current in its transit. It is to our past president, Sir William Thomson, that we are indebted for a solution of this difficulty, through the application of his celebrated mirror instrument, and his syphon recording instrument. This latter instrument, however, is of a somewhat delicate and complicated nature, and it would be desirable if its place could be taken by a relay of extreme sensitiveness, coupled with ordinary recording instruments worked by local circuits, the accomplishment of which result we may anticipate before long, considering the great improvements that have been effected in the construction of polarised relays.

It has lately been asserted that other countries, and especially the United States, are now taking the lead in telegraphic improvement. It cannot be denied that the more startling innovations of recent days have chiefly emanated from the United States, the only civilised country in which, as it happens, internal telegraph communication is still in the hands of private companies; and this open competition has no doubt been the stimulant — a stimulant which was equally active in this country in producing a variety of novel instruments at the time prior to the purchase of the telegraphs by the Government.

By this expression of opinion, the wisdom of the policy, which dictated the purchase on public grounds of the telegraphs by Government, is not called in question. Through it we have obtained a uniform and moderate tariff, and an extension of the telegraph system to minor stations. It is a question worthy of consideration whether the Acts of Parliament of 1868-69, by which the Government Department of Telegraphs was created in this country, do not go beyond the limits necessary to insure a well-regulated public service in taking the construction as well as the working of the lines out of the hands of public enterprise. They give, for instance, to the Department the faculty of purchasing letters patent, whereby an interest is created in favour of particular instruments, to the prejudice of others of perhaps equal merit, and such a course is by no means calculated to stimulate invention.

The erection of lines for local and private purposes is an important branch of telegraphy which should have remained entirely outside the scope of a public department, in order that competition might have a free opportunity of developing such applications, as is the case in the United States, where private and circular telegraphy is undoubtedly in advance of other countries.

Not that the officers of the Postal Department have been remiss in their efforts to improve the working of

the lines, for great improvements have indeed been recently made by the Postal Telegraph Department in the rate of working of Wheatstone's automatic circuits, and in the employment of fast-speed translators or repeaters. These instruments have improved the rate of working between London and Dublin about 50 per cent.

In submarine telegraphy ample scope still exists for the ingenuity and enterprise of the telegraph engineer; but here again the free exercise of these faculties is threatened, not by legislative action, but by a powerful financial combination. It is intended by this combination to merge the interests of all oceanic and international lines and the construction of new lines into one interest, to the exclusion of that wholesome competition for excellence, without which true progress is practically impossible. It seems hardly probable that such a monopoly will be able to maintain itself in the long run against that irrepressible spirit of British enterprise, which, though languishing at the present time of unparalleled depresssion, is likely to re-assert itself before long.

Much has been said about the application of electricity for producing light, but the complete realisation of all the advantages of the electric light remains a problem to be solved, and it would be extravagant to expect from applications on a small scale such as have hitherto been made anything like the amount of relative advantage indicated by theory.

The dynamo-electric machine besides being used for the light has been applied with considerable success to metallurgical processes, such as the precipitation of copper in what is termed the wet process of smelting. The effect of one-horse power expended in driving a dynamo-electric machine of suitable construction is to precipitate 1120 pounds of copper per 24 hours, equivalent to an expenditure of 72 pounds of coal, taking a consumption of 3 lbs. of coal per horse-power per hour.

Electrolytic action for the separation of metals need not be confined however to aqueous solutions, but will take perhaps an equally important development for the separation in a state of fusion of the lighter metals, such as aluminium, calcium, and some of the rarer metals, such as potassium, sodium, &c., from their compounds, as has been shown by Professor Himly of Kiel.

Experiments have been made with dynamo-electric machines with a view to ascertain the percentage of power that may be utilised at a distance, and the results of these experiments are decidedly favourable for such an application of the electrical conductor. Above 40 per cent of the power expended at the distant place may be recovered: the 60 per cent. lost in transmission includes the friction of both the dynamo-electric and electro-motive engines, the resistance of the conductor, and the loss of power sustained in effecting the double conversion. This amount of loss seems considerable, and would be still greater if the conductor through which the power were transmitted were of great length and relatively greater resistance; but on the other hand, it must be remembered that the power of a natural motor is obtained without expenditure of coal, and that a small caloric motor which the electric motor is intended to supplant is inconvenient and very extravagant in fuel.

In conclusion, Dr. Siemens said, that Electricity, which in the days of Franklin, Galvani, Volta, and Le Sage, was regarded as an ingenious plaything for speculative minds, and did not advance materially from that position in the time of Oersted and Ampère, of Gauss and Weber, and not indeed until the noonday of our immortal Faraday has, in our own times, grown to be the swift messenger by which our thoughts can be flashed either overland or through the depths of the sea to distances, circumscribed only by terrestrial limits. It is known to be capable of transmitting, not only language expressed in conventional cypher, but facsimile copies of our drawings and handwriting, and at the present day even the sounds of our voices, and of resuscitating the same from mechanical records long after the speaker has passed away. In the arts it plays already an important part through the creation by Jacobi of the galvano-plastic process, and in further extension of the same principle it is rapidly becoming an important agent in the carrying out of metallurgical processes upon a large scale. It has now appeared as the formidable rival of gas and oil for the production of light, and, unlike those inferior agents, it asserts its higher nature in rivalling solar light for the production of photographic images; and finally it enters the ranks as a rival of the steam-engine for the transmission and utilisation of mechanical power.

Who could doubt under these circumstances that there remains an ample field for the exercise of the ingenuity and enterprise of the members of that society I have just had the honour of addressing?

At the termination of the address, it was moved by Col. Crossman, and seconded by Mr. E. Graves, that the same be printed and presented to the members of the society.

A vote of thanks to the past-President, Professor Abel, was then moved by Mr. Latimer Clark and seconded by Major Webber, R.E.

A portrait of the past-President, being presented to the society by Lt.-Col. Bolton, a vote of thanks, put from the Chair, was passed for the same, and then on the motion of Mr. C. V. Walker, F.R.S., a vote of thanks to the Council of the Institute of Civil Engineers for their liberality in allowing the use of the Hall of the Institution for the Society's meetings, was carried unanimously.

On the motion of Mr. Bruce Warren, seconded by Mr. Donovan, a cordial vote of thanks was passed to Mr. W. Langdon, who resigns the office of Acting Secretary to the society.

An exhibition of the electric light from a magneto-electric machine of Messrs. Siemens, and of a new form of voltaic battery, the invention of Dr. Burns of Brooklyn, U.S., terminated the meeting.

THE INSTITUTION OF CIVIL ENGINEERS.

The first meeting after the Christmas recess was held on Tuesday, the 15th of January, when the newly-elected President, Mr. John Frederic Bateman, F.R.SS.L.&E., delivered an inaugural address.

After a passing allusion to the growth of the Institution, which at the end of 1844 numbered only 552 of all classes, now increased to 3,189, reference was made to some of the addresses of the eighteen gentlemen who had previously occupied the presidential chair, mainly for the purposes of comparison. Thus, Mr. Robert Stephenson, in summarising the statistics of British railways to the end of 1854, mentioned that 368 millions sterling had been authorised to be expended, of which 286 millions had been raised; whereas at the end of 1876 these figures were respectively 742 and 682 millions. Again, Mr. Locke, in treating of French railways, remarked that at the close of 1856 concessions had been granted for 7,030 miles, of which 4,060 miles were open; whilst at the close of 1876 these mileages were 16,452 and 12,715. Mr. McClean had contrasted the income available for taxation in 1815 with 1856, and had shown that in the interval the revenue from land had not increased, while that from houses had augmented 300 per

cent., and from quarries, mines, ironworks, canals, railways, etc., 1,200 per cent. There was evidence that since 1856 the increase had been very great, even if these high rates had not actually been maintained.

Proceeding to matters more personal to every member of the Institution, the President urged that engineering was but, in fact, the embodiment of practical wisdom; or, in the words of Bacon, "the conjunction of contemplation and action." Thought combined with practice had led to the perfecting of the steam engine by James Watt, to the successful application of the locomotive engine by George Stephenson, and to the production of the electric telegraph. It was to the combination of sound theory with successful practice, that engineering owed its present position, and had been able to advance material prosperity.

The President then gave a brief description of a few of the principal engineering works recently completed, or at present under construction; mentioning in telegraph engineering the telephones of Mr. A. G. Bell and Mr. Edison, and the quadruplex system of telegraphy, imported from America. During the past year electricity had put forward other claims than those relating to means of communication. Thus, the electric light, if it could not at present compete successfully with the convenience in domestic arrangements of gas lighting, had been found useful and effective for the illumination of large spaces, and the invention was about to be applied at the Lizard Point Lighthouses.

In the conviction that experience of a special kind, gained during a long professional life, was of more real value than allusions, however lucid, to a variety of subjects, the President next adverted to a question which was of the highest importance in that branch of the profession to which his attention had been more particularly directed, viz.,—the rainfall of this country, and the quantity of water which flowed off the ground, available for the use of man if properly utilised, or destructive when uncontrolled and permitted to cause floods or torrents. The variation in the rainfall was very great. For instance, on the east coast of England and Scotland the average did now exceed 20 inches per annum; on the south and west coast it was 35 or 40 inches; in the Penuine chain of hills forming the backbone of England, the quantity ranged from 40 to 60 inches; in the highest parts of Wales, Cumberland and Westmoreland a fall of from 60 to 80 inches was reached, while in some parts of the lake districts, it amounted to upwards of 150 inches. The observations of Mr. J. F. (afterwards Dr.) Miller, of Whitehaven, showed that the maximum density of the rain cloud was at about 2,000 feet above the sea level, although local circumstances exercised an important influence upon the quantity of rain which really reached the earth; that the greatest deposition of rain might be expected on that side of a mountain exceeding 2,000 feet in height, upon which the rain cloud impinged, but on the opposite side when the mountains did not rise so high; and that in a succession of ridges and valleys, without intervening mountains of a sufficient height to arrest the progress of the rain cloud, the greatest fall of rain would be in the first trough. In illustration, numerous observations on the rainfall in Lancashire and Yorkshire were given; and it was mentioned that the same results were observed in the lake districts of Dumbarton, Stirling, and Perthshire. As the quantity of rain varied in every dis-district and depended not only upon elevation but upon the physical and geographical features of the country, nothing could be more fallacious than to attempt to determine, by any fixed ratio, the amount of rain which would probably fall in any district, unless there were some corresponding one, similar in elevation, in proximity to the sea, in exposure to wind, and in other external circumstances with which to compare it. The proportion of this very varying rainfall, which would flow off the surface, depended largely upon the geological character of the rocks, their elevation and declivity, and the manner in which they were clothed with vegetation. The water passed off partly in floods and partly in perennial springs; that issuing from springs varying according to the physical features or lithological character of the district. Absorbent rocks yielded the greatest abundance; next, loosely stratified rocks, and least of all the closely bedded slate rocks and the primitive formations. Generally in the coal measures, the millstone grit, and the primitive formations, the quantity of spring water in the driest seasons would vary from about $\frac{1}{4}$ to $\frac{3}{4}$ of a cubic foot per second per 1,000 acres; $\frac{1}{2}$ a foot per second per 1,000 acres being an average quantity in a dry season. This quantity formed, however, but a small portion of that flowing off the ground in times of flood, which exceeded five or six hundred to one thousand times the quantity of water in dry seasons. The amount of flood waters was an important consideration in all engineering operations, as upon it depended the supply of large storage reservoirs, for canals, for water power, and for the use of towns,—the openings of bridges spanning rivers, the construction of river courses, the drainage of lands, and the effect in "scour" upon the beds of rivers and upon the mouths of harbours.

At the meeting on Tuesday, Jan. 22nd, Mr. BATEMAN, President, in the chair, the paper read was on "Some Recent Improvements in Dynamo-electric Apparatus," by Dr. HIGGS, Assoc. Inst. C.E., and Mr. BRITTLE, Assoc. Inst. C.E.

The authors commenced with a brief review of the rise and progress of this branch of electricity.

A description was then given of the latest construction of Siemens' Dynamo-Electric Machine and Electric Lamp, the latter devised specially for lighthouse illumination, and similar lamps were about to be supplied for the Lizard Lighthouses. The dimensions, weights, number of revolutions made by the cylinder, light equivalent in normal candles, and H. P. required for driving were, for three sizes of machines—

Dimensions in Inches.			Weight in lbs.	Revolutions of Cylinder.	Candles Light.	H.P.
Length.	Width.	Height.				
25	21	8·8	298	1,1000	1,000	1½ to 2
29	26	9·5	419	850	4,000	3 to 3½
44	28·3	12·6	1,279	480	14,800	9 to 10

In the application to lighting purposes the improvements in the present dynamo machines were very great. Thus, with a cost 10 times, with a weight 14 times, and a volume 25 times that of the latest construction, the old form of the machine produced one-fifth of the light, with an expenditure of practically the same driving power.

The results of experiments with the Electric Light Apparatus by Capt. ABNEY, R.E., at Fort Monkton, in July, 1875, were given.

An important factor in the light efficiency of a given machine was the resistance of the circuit leading to the lamps. Experiment indicated that, to obtain a maximum of light, the resistance of the conducting wires should be proportioned to that of the machine.

Much excitement had been evinced as to the probable competition between gas and electricity, as sources of light power. Although, under certain circumstances, these two agents undoubtedly came into

competition, they had two separate fields. Hitherto gas had been employed for lighting spaces of both large and small dimensions, because a better source of light for large spaces had not been procurable with economy. But for lighting large spaces not subdivided by opaque objects or screens, it was a want of economy to employ gas. Assuming light power proportional to H.P. expended, 100 H.P. would give 150,000 candles' light; distributed from three points, the cost would not be more than £1 2s. 6d. per hour, each light-centre giving an illumination which would enable small print to be read at a distance of a quarter mile from the light. A burner giving the light of 20 candles consumed 6 cubic feet of gas per hour, which might be manufactured at a cost of 2s. per 1,000 cubic feet. This gave 7,500 burners' light only, and 45,000 cubic feet of gas at a cost £4. 5s. per hour, a ratio of 4 to 1 in favour of electric lighting. The economical ratios differed greatly, being dependent chiefly upon the price of gas and of the motor power employed. For large spaces the cost of electric lighting was about one-fourth or even one-fifth that of gas-lighting, when steam had been used as power, and wear and tear were reckoned.

At Messrs. Siemens Brothers' Telegraph Works the economy was as 2 to 1 in favour of electric lighting. If, however, the ratio of light-intensities were adopted as the ratio of efficiency, the advantage would be considerably higher (20 to 1) in favour of electric lighting. It might be laid down as proved by experience, that for lighting large spaces, not too much subdivided, the advantage was greatly in favour of the electric light; but that where numerous light-centres of small intensity were required, or where the space was much subdivided, the advantage was in favour of gas. This advantage would cease when a practical method of subdividing the electric light was obtained.

The limit set by distance to the transmission of power, by means at present adopted, had been comparatively narrow. Hydraulic power had been the most adaptable, with, however, several important disadvantages. Although electricity as a means of transmission was also limited by the distance to be traversed, the limit was in this case much more extensible, and under favourable instances practically disappeared.

The employment of the currents of magneto-electric machines for electrotyping and electroplating had long superseded the voltaic current. It was, however, only on a large scale that the current from a dynamo machine could be used with advantage. For small electro separations, or depositions, magneto-electric machines had been constructed. For the deposition of large quantities of metal, where by changing baths in succession little change was made in the total circuit resistance, the dynamo machine gave much greater economy. With one of these machines, and a proper succession of vats, as much as three tons of copper had been deposited daily.

PHYSICAL SOCIETY.—19TH JANUARY, 1878.

The President, Professor G. C. FOSTER, in the Chair.

THE following candidates were elected members of the Society—J. Angell, Lieut. G. S. Clarke, R.E., T. F. Iselin, M.A., J. W. Russell, M.A.

Mr. W. H. PREECE read a paper "On some physical points connected with the Telephone." This instrument may be employed both as a source of a new kind of current and as the detector of currents which are incapable of influencing the galvanometer. It shows that the form and duration of Faraday's magneto-electric currents are dependent on the rate and duration of motion of the lines of force producing them, and that the currents produced by the alteration of a magnetic field vary in strength with the rate of alteration of that field; and further, that the infinitely small and possibly only molecular movement of the iron plate is sufficient to occasion the requisite motion of the lines of force. He pointed out that the telephone explodes the notion that iron takes time to be magnetised and demagnetised. Mr. R. S. Brough has calculated that the strongest current employed in a telephone is $\frac{1}{1000000000}$ of the C. G. S. unit. Mr. Preece explained that the dimensions of the coil and plate depend on the strength of the magnet; but the former should always consist of fine wire, and be made as flat and thin as possible. The adjustment of the position of the magnet (as near as possible to the plate without touching) is easily effected by sounding a vowel sound *ah* or *o* clearly and loudly; a jar is heard when they are too near together. After briefly enumerating the attempts which have been made to improve the instrument, he mentioned the various purposes to which it can be applied. In addition to being useful in the lecture room, in conjunction with several well-known forms of apparatus, it forms an excellent detector in a Wheatstone Bridge for testing short lengths of wire, and condensers can be adjusted by its means with great accuracy. M. Niaudet has shown, by employing a doubly wound coil, that it can be used to detect currents from doubtful sources of electricity, and it is excellent as a means of testing leaky insulators. Among the facts already proved by the telephone may be mentioned the existence of currents due to induction in wires contiguous to wires carrying currents, even when these are near each other for only a short distance. Mr. Preece finds that if the telephone wire be enclosed in a conducting sheath, which is in connection with the earth, all effects of electric induction are avoided; and further, if the sheath be of iron, magnetic induction also is avoided, and the telephone acts perfectly. A great number of experiments on the use of the instrument on telegraphic lines were then described, from which it appears that conversation can be carried on through 100 miles of submarine cable, or 200 miles of a single wire without difficulty, with the instrument as now constructed. The leakage occurring on pole lines is fatal to its use in wet weather for distances beyond five miles. An interesting series of telephones was exhibited, and by means of one of very large dimensions, Mr. Preece showed that the current produced by pressing the centre of the plate sensibly affects a Thompson galvanometer, and that the motion of the needle ceases in a remarkably instantaneous manner as soon as the pressure is removed, a necessary condition in order that the receiving plate should acurately reproduce the motions af the sending plate.

In the discussion which followed, Mr. R. SABINE suggested that the failure of all attempts at improving the instrument by increasing its dimensions might be due to the *damping* action of the permanent magnet on the plate, the strain on it being proportional to the size of magnet, and rendering it less sensitive to the sonorous waves. Mr. COFFIN pointed out how interesting it would be, if instead of employing a receiving instrument, the currents could be communicated directly to the auditory nerves; and Professor ADAMS explained the relation subsisting between the character of the vibrations of the disc and the character of the electric currents to which they give rise.

Dr. LODGE desciibed a simple form of apparatus for determining the thermal conductivity of rare substances such as crystals, which cannot be obtained in slabs or rods.

THE METEOROLOGICAL SOCIETY.

THE Annual Meeting of this Society was held on Wednesday, the 16th inst., at the Institution of Civil Engineers, 25, Great George Street, Westminster. Mr. H. S. Eaton, M.A., President, in the chair.

The council in their report express their gratification at the increase in the number of Fellows and Stations of the Society; the greater size of the Quarterly Journal and the high value placed on it by foreign scientific societies; the augmentation of the Library, and the addition to the sum hitherto contributed by the Meteorological Council, as well as at other evidence of vigour and progress manifested during the year. The number of Fellows now amounts to 417.

The President then delivered his address:—"During his tenure of office the alliance between the Meteorological council and the Society had been further cemented, the Society supplying the Government with certain statistics, and getting some assistance from the Council in return. This arrangement had been completely successful, and the president considered it calculated to foster the growth of climatic meteorology under the auspices of the Society, and likely to remove any jealousy on the part of the public towards a Governmental Department, so peculiarly constituted as the Meteorological Council. After criticising some of the work undertaken by the last-mentioned body, Mr. Eaton exhibited curves of the results of the hourly observations of the barometer and thermometer for the year 1876, at Valencia, Armagh, Glasgow, Aberdeen, Falmouth, Stonyhurst and Kew, these being the stations established in 1868 for determining the meteorological constants of the British Isles. The curves showing the combined diurnal and semidiurnal variation of atmospheric pressure might be referred to one of two distinct types. In one of them the minimum of pressure was most pronounced in the morning, in the other in the afternoon. The former type was found at the maritime stations of Valencia and Falmouth, the latter at inland stations such as Kew. The diurnal range of the temperature of the air was duly related to the pressure. It was least at the maritime stations, reaching only 4° at Falmouth and attaining a maximum of 9·3° at Kew.

The following gentlemen were elected officers and council for the current year:—

President—Charles Greaves, M. Inst. C.E., F.G.S.; Vice-Presidents—Henry Storks Eaton, M.A., James Park Harrison, M.A., Robert James Mann, M.D., F.R.A.S., Charles Vincent Walker, F.R.S., F.R.A.S.; Treasurer—Henry Perigal, F.R.A.S.; Trustees—Sir Antonio Brady, F.G.S., Stephen William Silver, F.R.G.S.; Secretaries—George James Symons, John W. Tripe, M.D.; Foreign Secretary—Robert H. Scott, M.A., F.R.S.; Council—Honourable Ralph Abercomby, Arthur Brewin, F.R.A.S., Charles Brooke, M.A., F.R.S., F.R.C.S., Edward Ernest Dymond, William Ellis, F.R.A.S., Rogers Field, B.A., M. Inst. C.E., John Knox Laughton, M.A., F.R.A.S., Rev. William Clement Ley, M.A., Richard Strachan, Henry Samuel Tabor, Capt. Henry Toynbee, F.R.A.S., George Mathews Whipple, B.Sc., F.R.A.S.

General Science Columns.

ON THE PREVENTION OF FLOODS.

THE large amount of rainfall in England during the last three years, and the consequent flooding of rivers, has caused considerable attention to be directed to the question of floods, with the view of discovering what means can be adopted to avert or remedy them. The Ouse, the Witham, and the Trent have, amongst others, formed the subject of special investigations; and last session the Thames was favoured by being referred to a special committee of the House of Commons.

It is natural that in the rapid advance of engineering science such a subject as the prevention of floods should be brought prominently forward, but the solution of the problem has not hitherto been effected. Floods still occur in every part of the country, and we have quite recently seen large tracts of meadow land covered with water after two days' rain. In July, 1875, the Ouse rose so rapidly at Huntingdon, that the booths erected on the large common outside the town in anticipation of the races, were hastily deserted by their occupants, and the races abandoned. In the same year, large quantities of hay were swept away, and much other damage done in various places. Last winter, there was an alarm that the Trent bank, in the neighbourhood of Lincoln, was in danger of breaking, and the Witham banks did actually give way, and a large extent of fen land below Lincoln was inundated, driving many people from their houses and doing great injury to the crops. The Thames overflowed its banks in many places during the last two winters, and the occurrence of floods in London itself, need scarcely be recalled to the memory of our readers.

Rivers are the channels formed by nature for the discharge of the rainfall to the sea, but generally they are not sufficiently large to carry off more than an average amount of rain, and floods are the natural result of any continuous heavy rainfall. The frequently expressed opinion that floods are more common than in former times appears to be correct; but this is due, not to any increase in the rainfall, but to the reclamation by means of embankments, of large tracts of land bordering the rivers which used formerly to serve as flood reservoirs; to the growth of weeds and the formation of obstructions by the fall of trees or washing away of the banks, and to the extension of subsoil drainage on the higher lands which brings the water down more rapidly into the rivers. The existence of mills and the canalisation of rivers for navigation purposes are detrimental to the free discharge of flood waters. When rivers are large, like the lower portions of the Thames, they have naturally been adapted to navigation, and in smaller rivers, where the fall is considerable the available water power has been utilised by the erection of mills. Millers are naturally unwilling to let off much water through their sluices in the summer for fear that a drought should follow, and in the winter they frequently keep up the water above in time of flood in order to maintain a sufficient head of water to drive their mill when the water tails up below them. The abandonment of navigation, even on the upper portion of the Thames, was considered unadvisable by the Thames Floods Prevention Committee, and any proposal to obtain the relief that might be afforded by this means, would raise considerable opposition; and

the vested interests in mills are so large that their purchase and removal would not be practicable. The rivers must, therefore, be dealt with in their existing artificial state.

To avert all danger of flooding would necessitate a very large outlay; and, moreover, such a thorough measure is not required, as the winter floods, which are the most frequent and the most extensive, are not generally injurious, except where they reach dwelling houses. Where houses are below flood level, they should be protected by embankments; and it should be entrusted to the local authorities of every town to take care that no buildings shall be erected in future on low lands, unless the sites have been efficiently protected from all chance of floods. It is a scandal that houses should be built, as we have seen them, with the ground floor window-sills below flood level. The speculative builder erects houses on low land obtained at a cheap rate, and then sells them in dry weather to unsuspecting persons unaware of the impending floods. The farmer dreads merely the summer floods, which may ruin his grass, carry off his hay, destroy his growing crops, or render his pasture land unpalatable to cattle.

The size of the channel required for an efficient discharge depends upon the rainfall of the district, the area of the water-shed, the permeability or impermeability of the strata forming the basin, and the amount of fall; each river basin, therefore, requires a separate investigation. It is always possible to devise means for averting floods, but where the fall is small the channel must be large, and where the fall is very slight, as in the fen districts, pumping must be resorted to the lift given being practically so much addition to the fall of the bed. The advantage of pumping is that it can be applied to any extent; but besides the first cost of erecting the pumps, there is an annual expenditure. Much may be done by removing weeds and other obstacles from the river bed, enlarging outfalls, shuttles, and tumbling bays at the rivers and mills, straightening the course of the stream where sharp bends occur, rendering its section more uniform, and removing old bridges with contracted waterways and replacing them by bridges with larger openings.

The whole matter resolves itself into one of cost; what amount might be profitably expended in abating floods, and how the requsite money is to be raised. The amount of profitable expenditure depends upon the extent and value of the flooded lands, and the amount of protection or relief required.

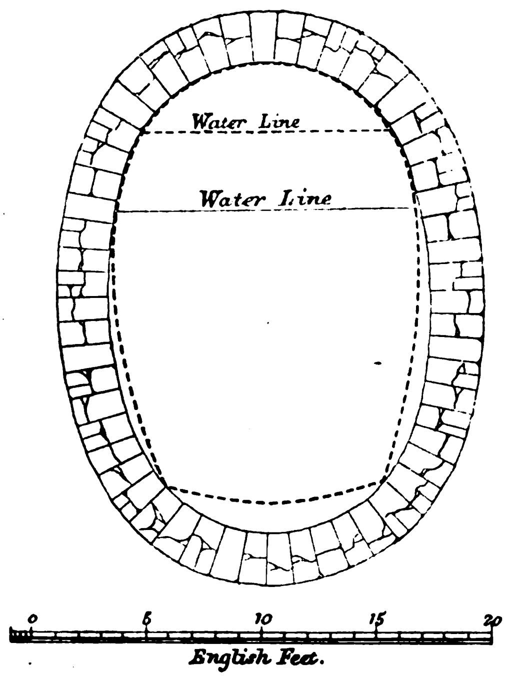
With regard to the raising of the necessary funds, there arises the difficulty that the area of the flooded lands is usually very small in proportion to the whole area of the basin, and the proprietors, moreover, in many instances are unable to bear a heavy rate, especially when their profits have been greatly reduced by a succession of rainy seasons. It appears to us, however, an equitable arrangement that the area of rating should be extended to the entire watershed of a river, and that the more fortunate holders of the higher lands should bear some proportion of the burden of relieving the low lands from floods, as the rain which falls on their land is discharged by the river below, and they have in most instances helped to increase the floods by subsoil drainage. The equalisation of rates in the parishes of London, which shifted a portion of the burdens of the poorer parishes on to the richer ones, and made all pay their proportionate share, is a measure which is manifestly just, and affords a precedent for the arrangement we suggest. To ensure a proper control and supervision of the watercourses of the kingdom, each large river, with its tributaries, should be placed under the jurisdiction of a single board, chosen from persons interested in the district, and armed with ample powers for enforcing at all times the discharge of water to any desired extent at the weirs, sluices, and mills, and the maintenance of a clear and sufficient channel. It is probable that if the course we have indicated were adopted, the periodical complaints about floods would cease, and the rivers become efficient channels for the discharge of floods throughout the summer season.

The French have set us an example by the study they have made of the flow of their rivers; and in the case of the Seine, M. Belgrand, the director of these investigations, by receiving telegraphic information of the rainfall and rise of the upper portions of the river, has been able to predict both the time and height of the floods along the lower parts of the river, and thus give timely warning to the inhabitants of the district, and he considers that this system might be readily applied to many other rivers.

DRAINAGE OF LAKE FUCINO.

LAKE FUCINO was situated in the ultra Abruzzi province, about 53 miles in a straight line, east of Rome, and 96 miles north of Naples. It was the largest lake in Central and Southern Italy, and covered the greater part of one of the largest table lands to be met with in the central part of the Apennines, having an area of about 173,000 acres. This table land is surrounded on all sides by spurs of the main chain of mountains, thus forming a basin quite separated from the adjacent valleys, so that the waters produced on its surface found no outlet by which they could discharge themselves into the neighbouring rivers. The most important as well as the nearest of the valleys situated on the other side of the mountains which gird the Fucino basin, is that of the Liris, which to the west runs parallel for a certain distance with the plateau of the lake, but at a lower level. The river is about 3½ miles in a straight line from the lake, but between the two there is a mountain, Mount Salviano, and another plain called the *Campi Palentini* higher than that of Lake Fucino. Julius Cæsar was the first to conceive the idea of draining the lake; it was attempted by Claudius, the fourth Emperor in succession from him, and the works which he caused to be executed were considered by Pliny as the most extraordinary of

that age, itself the most brilliant in the history of Roman civilisation. We learn from Suetonius that for eleven consecutive years thirty thousand men were employed at Lake Fucino; Pliny the elder, who saw the works in full activity, says that they cost incalculable sums and where so extraordinary, that no language could give an idea of them. The nature of these works was the excavation of a tunnel through Mount Salviano, at about 984 feet below its summit, and its continuation under the Palentine fields, at an average depth below the surface of 328 feet, with the view of discharging the waters from the lake into the river Liris, at a sufficient height above the latter to enable it, even when in flood, to receive the water from the tunnel. This work was called the emissary of Claudius. Its total length



was 6,114 yards, and it was constructed with a gradient of 1½ in 1000. So far as could be judged from the ruins of the tunnel, its cross section was to have had a surface of 11·9 square yards, but in the execution of the work these proportions were not maintained, and the invert of the tunnel was not kept at the regular slope it should have had. Between its two extreme points, the course of the tunnel was not quite straight, but followed a broken line composed of three sections forming very open angles with each other. In carrying out the work, forty shafts were sunk, of which twenty-nine were situated between the foot of Mount Salviano and the river Liris, and the remainder between the mountain and the lake. The depth of the first group ranged from 232 feet to 400 feet, and that of the second between 57 and 203 feet. In the course of the recent works for reconstructing the Roman tunnel, one of the ancient shafts was opened. The timbering with which it had been lined, though carbonised from its long stay underground, was still in its place, without having shifted in the least. The sides of the square, each measured 14·16 feet, and were supported in the middle by strong cross beams, which thus divided the aperture of the shaft into four equal compartments, each 5·16 feet square. These were made use of for hoisting up the material excavated from the tunnel in skips or buckets, which had a cylindro-conical shape, and were made of copper, strengthened with broad bands of soft iron. Their capacity was only 1·4 cubic feet, and they were suspended by means of hooks, to ropes set in motion by men working at the bars of a vertical capstan, which was mounted on a wooden framework close to the mouth of the shaft. Each shaft had two such capstans, so that two buckets could ascend and two descend simultaneously. This tunnel, after its completion, was opened with great ceremony, and the waters of the lake began to discharge themselves into the Liris, but by an error in the construction of the entrance works, it was impossible that the lake could ever have been thoroughly drained. This defect was corrected, and at a second inaugural *fête*, the regulator was carried away, and although the draining continued for some months, the works were neglected, and allowed to fall into decay. Attempts to re-open the works were made by Trajan and Hadrian, and in the middle ages by Frederic II., perhaps also by Alphonso I. of Aragon, and by several sovereigns of Naples, but always in vain. This long succession of failures had caused the draining of Lake Fucino to be regarded as an impossibility, till Prince Torlonia succeeded at last in overcoming the difficulties, which for eighteen centuries had resisted all the attempts of the most powerful sovereigns.

In 1851, owing to the injury caused by the rising of the lake, a company was formed to whom a concession was granted for the drainage of the lake, on condition that they should carry out all the works at their own risk and cost, and receive in exchange the proprietorship of the lands they should reclaim. The engineers to whom the execution of the works was entrusted were Messrs. Charles Hutton Gregory and William Parkes, who were respectively appointed consulting and resident engineers. After elaborate surveys and examinations on the spot, an exhaustive report, a copy of which is now before us, was submitted in February 1854, recommending the construction of a tunnel of 230 superficial feet opening, of which 165 feet was intended to be the maximum area of the stream running 14 feet deep, leaving above it an area of 65 feet for the passage of air. While the constitution of the company was under discussion, the late M. de Montricher submitted to Prince Torlonia a proposal based on the data obobtained by the English engineers, of which the main feature of difference was that the tunnel was to have an area of 130 feet section, instead of 230 feet, and consequently be much less costly. Prince Torlonia having purchased up the rights of the company, undertook the work at his own sole cost, and appointed M.

de Montricher, the engineer-in-chief. He subsequently submitted to Prince Torlonia an amended project for a tunnel 217 feet area, with the stream to run 17½ feet deep, and 195 feet area, leaving 22 feet free. This project was afterwards carried out, and thus, the great saving of cost, which would have been effected by the reduced area of tunnel in M. de Montricher's first design, was not realised, while the previous conclusion of the English engineers as to the capacity that should be given to the tunnel was fully confirmed. The whole of the details appear to have been newly designed under M. de Montricher's directions, but on principles identical with those on which the details of Mr. Gregory and Mr. Parkes were based. The accompanying sketch shows the cross section of the tunnel proposed by Mr. Gregory and Mr. Parkes, whilst the dotted lines within it show the cross section adopted by M. de Montricher. This is given in order to show how closely the French engineer followed upon the design of the English engineers.

The construction of this tunnel necessitated the destruction of the old Roman tunnel. Upon the section adopted, and with a general slope of 1 in 1,000, it was calculated that a discharge of 11004·834 gallons per second would be obtained. The invert of the Torlonia tunnel, at its outfall on the Liris, is placed 2·65 feet lower than the Roman tunnel at that spot. From this point a slope of 2 in 1,000 is given to the first 393·6 yards of the invert, and 1 in 1,000 to the rest of its course. The works began with the erection of a dam, destined to isolate as much as possible the head of the Roman tunnel and the structures in front of it, from the waters of the lake. This dam was formed by two parallel arms, 240·598 yards distant from each other, and connected by a curve of 120·299 yards radius, its total length being 1640·44 yards. Within this was another dam, the space enclosed between the two being 32 acres. These works were begun on the 10th of July, 1854. In the construction of the tunnel, several of the old Roman shafts were re-opened, whilst in some cases entirely new shafts were sunk. During the course of construction of the works, temporary expedients were adopted for a partial drainage of the lake on two separate occasions. The Torlonia tunnel was completed in November, 1869. It has a total length of 6887·51 yards, of which 2813·3 yards were excavated through compact rock, and left without revetment; 344·3 yards through pudding stone and lined with bricks; and 3729·8 yards through clay, detached rocks, &c., where it is lined with strong masonry of hewn stone. For its construction 28 shafts were sunk or repaired, twelve of which were over 279 feet in depth; and two inclined galleries were constructed, having a total length of 568·3 yards. The head works of the tunnel were constructed subsequently; they are as follows:—Before reaching the entrance of the tunnel, its cross section gradually increases both in height and width along a distance of 21·8 yards, until it reaches an area of 430·56 square feet at its mouth. The head of the tunnel consists of a pile of masonry built of hewn stone 20·34 feet in depth, provided with a cutwater. This pier divides the tunnel into two parts, the cross section of each of which is a little more than one-half of the area of the cross section of the tunnel. The head of each of these is fitted with a safety sluicegate. In front of the tunnel there is a basin, called the regulating basin, the bottom of which is at the same level with the sill of the tunnel. This basin is rectangular, and at the side opposite to the entrance to the tunnel is a dam, which also forms the end of the canal excavated to conduct the waters of the lake to the tunnel.

The direct results of this drainage have been the recovery of about 35,000 acres of land which were formerly submerged; but the indirect results in affording protection to land that was previously submerged, and increasing the salubrity of the locality have been of no slight benefit. The works undertaken comprised, besides the tunnel itself, planting, drainage, construction of roads, &c., &c., and they have cost, including interest on capital outlay, and all other incidental and miscellaneous charges, nearly £1,800,000, the whole of which has been borne by Prince Torlonia.

MANUFACTURE OF RUBIES.—At a recent *séance* of the French Academy of Sciences, MM. Frémy and Feil, gave an account of their processes for the artificial production of corundum and many other crystalline silicates, and illustrated it with some splendid samples of their labours. The artificial production of crystallised alumina, which is the basis of a great many Oriental gems, and especially of the ruby and sapphire, has hitherto engaged a number of experimenters of whom Ebelmen and Senarmont were the chief. These did not, however, succeed in making any other than extremely small crystals. MM. Frémy and Feil, on the other hand, have produced crystals of a size capable of being used in watch-making, and cut by the lapidary. The process consists in keeping for a considerable time, at a red heat, a mixture of aluminate of lead and silica. The experiment with thirty kilogrammes of the mixture has been kept up during more than twenty days in the oven of M. Feil. Under the action of the heat, the alumina disengages itself little by little from the lead, and crystallises out as colourless corundum; but if two or three per cent. of bichromate of potash is introduced into the mixture, the crystals acquire the tint of rubies. In the same way, with a little oxide of cobalt for colouring matter, sapphire is produced. In density, hardness, brightness, and even colour, the agreement between the artificial and natural stones, is said to be most accurate, and M. Jannettaz has found the optical and crystallic properties to be identical. Among other silicates obtained by MM. Fremy and Feil, disthene may be mentioned. It crystallises out in long, colourless spines or needles, similar to those found in nature. The authors stated that they had in

view only the scientific aspects of the subject, and freely made their process public.

A Spectroscope with a Fluorescent Eye-piece.—Mr. J. L. Soret has published a detailed account of his application of the well-known property of fluorescent substances to the observation of the ultra violet portions of the solar spectrum. He places a screen made of the fluorescent body at the focus of the object glass, so that an image of the spectrum falls upon it, and examines the projected image by means of an eye piece placed obliquely, so that the diaphragms and blackened walls of its tube extinguish the direct rays from the spectrum. The screen is either a plate of uranium glass or a cell filled with an aqueous solution of esculine; and the spectroscope is best fitted with lenses of quartz and prisms of Iceland spar. When the lenses were of glass, and the prisms of flint, the spectrum lines could not be distinguished beyond N; but with quartz lenses and spar prisms, they were visible as far as T. M. Soret has made observations on the Alps at 3180 metres high, and concludes that although the ultra-violet spectrum is more brilliant at high elevations than on plains, it has no greater extent. In these observations he could not distinguish rays more refrangible than T. He infers that it is the atmosphere of the sun, and not that of the earth which absorbs the most refrangible rays of the spectrum. The observed diminution of brilliance in the more refrangible portion of the spectrum on passing from a higher to a lower altitude, he considers to be due, not to selective absorption by the constituent gases of the air, but to the action of floating particles of liquid or solid impurities which, when more than usually abundant, produce an evident haze or collect in clouds. The general absorption of light due to the last cause affects all the rays of the spectrum; but to a greater degree in proportion as the rays are more refrangible.

Oxidising Effect of Sunlight.—M. Chastiany considers the oxidation of certain inorganic metallic compounds to be a definite effect of the sun's rays, and locates this peculiar oxidising power in a different part of the solar spectrum from the well-known reducing power. His conclusions are chiefly drawn from the observation that oxidation of such substances as ferrous sulphate, alkaline solution of arsenious acid, and aqueous solutions of hydric sulphide, or alkaline sulphides, proceeds more rapidly in the light than in the dark; and he endeavours to estimate the action of the light by the difference in the rapidity of the process in the two cases, all other conditions being the same. He is of opinion that the chemical action of the rays of the solar spectrum on metallic compounds, both salts and binaries, is a reducing action at the more refrangible or blue end, and an oxidising action at the less refrangible or red end. The general reducing action of white light is perhaps due to the fact that in the rays as a whole, the reducing action is the most powerful of the two. The green rays, he takes to have a reducing influence, but locates between the rays D and E, a neutral point in the spectrum, at which chemical action takes place as it does in darkness. On organic bodies, however, it appears that the action of light is always of an oxidising tendency, and this effect increases on passing from the red to the violet end of the spectrum, with a probable variation from the law in the green rays.

Chemical Action of Light.—Professor H. W. Vogel, in opposition to M. Chastiany's theory, that the chemical action of the various rays of the spectrum on inorganic substances depends on their refrangibility, maintains that the nature of the substance causes the action to be of a reducing or an oxidising nature. Professor Vogel regards the rapid union of Hydrogen and Chlorine in violet light as analogous to oxidation, and he refers to the recent experiments of Zimiriazeff, shewing that the reduction of carbonic acid by plants proceeds more rapidly in red than in green light.

Utilisation of Slag.—The ordinary waste slag from iron smelting furnaces has been of late very ingeniously utilised by a young English engineer, named Dickinson. Mr. Dickinson transforms it into sand, and also into mineral wool. The process in both cases is simple, but surprising. To turn into sand the molten slag is run into a rotating water wheel, which has the effect of granulating it so that in a few minutes the red hot fluid slag can be carted away in the form of sand. To turn it into wool, the molten slag is made to flow out of a pipe, and a jet of steam is played across the surface of the outflow. This has the curious effect of tearing off the slag in the form of very fine glassy fibres, white and lustrous as wool. The steam carries the fibres with it against a screen of netting, from which they are gathered. Being an excellent non-conductor, this mineral wool is used for packing in engines.

Uses of Water Glass.—The uses of silicate of soda are more and more extending, notwithstanding that the business of its manufacture is still in its infancy. The greatest demand is for soap making. It is better than the addition of resin, and its alkalinity adds to the cleansing power. It retains water, keeps the soap from shrinking, and prevents great loss of weight. It can scarcely be called an adulteration. It is used as paint, and mixes with all mineral colours; there are even now factories which make paints of mixtures of oil paints and water-glass. It makes the paint more durable, and gives it a gloss-like varnish. It is also indispensable as a mordant for calico-print works, and at present, therefore, extensively used as such. It makes an excellent fireproof cement for stone and iron foundries, especially in putting up iron fronts for buildings. It is the main ingredient in several methods of making artificial stone. For instance, in the Ransome

process, which, in England, consumes thousands of tons yearly. It makes an excellent adhesive mucillage, and is used in a cheap mixture to mend china, glass, and wood. Being perfectly fire-proof, it will give its quality to wood or paper when this has been soaked in it; and being, when dry, also water and damp proof, it is the best coating for brick vaults, and thus very valuable for beer brewers, sugar refiners, &c. These are not all the praiseworthy qualities of this valuable material.—*The Polytechnic Review.*

IRIDESCENT GLASS.—A process for making this glass iridescent has been patented by M. Clenandot. Beautiful effects are produced. The main feature of the process is the application of acids to the glass, under a pressure of from two to five or more atmospheres. Water containing 15 per cent. of hydrochloric acid, is used to bring out rainbow tints like mother of pearl, and artificial gems of various sorts have thus been manufactured. The glass prepared by these processes is quite as iridescent as is that which antiquarians so much value; the pressure and the acids hastening a result that the ordinary agencies of the atmosphere would take centuries to produce.—*New York Tribune.*

CRYSTALLISED GLASS.—M. Vizeau, Director of the Blanzy Glass Works, has obtained some beautiful crystals of glass from a crucible that had been in use during eight and a half months in a Siemens' furnace.

NITRATE OF LEAD AS A DEODORISER.—A writer in the *Lancet* recommends nitrate of lead as a quick and effective deodoriser. Half a dram of nitrate dissolved in a pint of boiling water, when mixed with a pail of water in which two drams of common salt have been dissolved, forms, when the sediment settles, a deodorising fluid of great power. A cloth dipped in it and hung up in a fœtid apartment will, it is stated, soon sweeten the atmosphere.

FORM OF MOLECULES.—Professor J. Clerk Maxwell deduces from the conclusions of a paper by Herr Boltzmann "On the Nature of Gas Molecules," that the molecules of chlorine, ammonia, and sulphuretted hydrogen are rigid elastic bodies; those of hydrogen, oxygen, nitrogen, air, carbonic oxide, nitrous oxide, and hydrochloric acid, smooth figures of revolution and those of mercury, gas smooth spheres.

DISCOVERY OF SPRINGS.—M. Baour points out that permanent supplies of underground water may often be discovered by observing the area over which the air quivers on a clear summer day, when the sun is near the horizon and the air is still. Some of the success formerly attributed to the "divining rod" may have been due to an acquaintance with this mode of search.

INFLUENCE OF TREES ON MOISTURE.—M. Fautrat, from observations made in France, finds that more rain falls on forest than on open land, and on pines rather than on leafy trees. Pines retain more than half of the water that is precipitated upon them, while leafy trees allow 58 per cent. to reach the ground. Pines are therefore the best safeguard against sudden inundations and the best means of giving freshness and humidity to an arid climate like that of North Africa.

INCOMBUSTIBLE SILICATE BOARD for roofing is being manufactured in Belgium. It is prepared by saturating alternate layers of pasteboard with silicate of soda and with a solution of chlorate of barium or other salts, which produce insoluble silicates, such as salts of zinc, calcium, magnesium, and aluminum. The mass of the board hence becomes saturated with insoluble silicate of barium and silicic acid, which render the material at once fire and weather proof. The preparation can be applied to paper, wood, and textile fabrics, and to finished articles as well as to raw materials. The board is light, durable, and tough. It is also capable of being decorated with colours, and is said to cost little.

Tiles of Asphalt for flooring purposes have also been recently employed in Bavaria.

AN ARTESIAN WELL for the purpose of supplying the public baths and municipal establishments of the city is now being bored at Pesth, in Hungary. It has already been sunk to a depth of 951 metres, and is the deepest well in the world. The outflowing water has a temperature of 161° Fah., but it is intended to continue the boring until the temperature of the water is 178° Fah. The jet shoots up 35 feet above the orifice, and 175,000 gallons of warm water are delivered daily. This quantity is more than sufficient for the needs of the city, and some of it will probably be utilised in converting the space surrounding the well into an artificially-heated garden. A motor capable of being driven by the water-jet has also been invented.

City Notes.

Old Broad Street, Jan. 31st, 1878.

IT is gratifying to us to find that the policy we have throughout pursued in the conduct of this department of the *Telegraphic Journal* is being emulated the other side of the Atlantic, where, as in England, the ignoble army of monopolists have done their best to make things pleasant for themselves. Not only does the *Operator*, a lively and well-conducted journal, devote a leading article in which, while announcing the formation of a powerful telegraph company, it warns the monopolists that their day of triumph may be over; but the *New York Tribune* administers a sharp rebuke to the wire pullers, and finally tells them that "the rule that a monopoly cannot long exist in a free republic is a safe one to rely upon." It is true that the opponents of monopoly are even now compelled to

admit that the new company may go the way of its predecessors, and fall into the hands of the Egyptians. We shall watch the issue of the conflict with great interest; but whatever delay there may be in the defeat of the monopolists, the end is not dubious. As our contemporaries intimate, the American public will not continue to pay high rates when low ones are possible. We can assure our friends who are fighting against monopoly in America that what is true of a free republic is true also of a country governed by a limited monarchy. Monopoly, for any length of time, is quite as impossible here as it is in the United States. Mr. Pender and his associates did, undoubtedly, lay their plans with extraordinary skill, and it would be as foolish to deny that they have obtained an apparent victory, as it would be to maintain that they have sacrificed their own interests to those of the general public, or of the shareholders whom they have led captive at their will. But they, like the monopolists in the United States, have digged a pit for their own feet.

We have no authority for stating that the French cable scheme, more popularly known as the "Pouyer Quertier" scheme, will come before the public immediately; but it is engaging a great deal of attention just now both in this country and in France. The fact that half the capital is subscribed justifies this, and it is no secret that the company is being backed by very powerful influence. It may soon prove something more than a phantom to the monopolists who still affect to ridicule the idea of opposition.

So, too, may the bill we recently alluded to at some length as being before the American House of Representatives, though we confess that the latter scheme is rather extensive. If we are rightly informed, the promoters propose to connect the United States by way of the Azores, with Portugal, France, and England, continuing the cable along the Mediterranean and also across the North Sea to Russia. It is urged that by the construction of this cable, America would, in the event of war with England, be rendered independent of the English companies. But that plea seems hardly worth consideration; the chances of war between this country and America are extremely remote—so remote indeed that it would be idle to discuss them. Americans are, we know, very fond of going in for big things, but it is folly to attempt to do too much, and the scheme would be more likely to find general favour if it were limited to connecting France and England only with the States.

The dividend declared by the Eastern Telegraph Company is at the rate of 5 per cent. per annum on the ordinary shares. We have not been favoured with a copy of the report, but we gather that the chairman of the company is well satisfied with the half-year's operations—that is one blessed result. Mr. Pender announced at the meeting that the duplication of the cables had been a financial success, and he quoted figures to prove that the income of the company had considerably increased during the six months. It does not appear to have occurred to any one to raise the point, but we observe that an item of £14,000 of the amount expended in repairs to the cables was charged to the reserve fund instead of to revenue. This ought not to be. All repairs to cables are properly chargeable to, and should be paid out of, revenue. If the principle of absorbing a reserve fund to meet the expenses of cable repairs were generally recognised, it would be a serious matter. What constitutes a current expense in the case of the Eastern Company if cable repairs be not one? Mr. Pender concluded his speech at the Eastern meeting by stating that the directors of the company "were always open to encourage scientific men and inventions." The remark must have provoked many a smile from telegraph engineers, whose interests, as we showed in our last, Mr. Pender has done so much to promote.

The Directors of the Direct United States Cable Company have resolved upon the payment of an interim dividend of 5s. per share, being at the rate of 5 per cent. per annum for the quarter ending, Dec. 31, 1877. The dividend will be payable on and after the 11th of February.

We shall, no doubt, have something to say about the report of the Anglo-American Company, and the proceedings at the half-yearly meeting; but the bald resolutions which were passed at a recent meeting of the Board do not call for comment. The dividend upon the ordinary consolidated stock for the last half-year the directors recommend at 1½ per cent, a balance dividend of 1 per cent. upon the preferred stock for the half-year, and a first and final dividend of 2 per cent. on the deferred stock for the year, making in all, with the dividends already paid, 4 per cent. on the ordinary stock for 1877.

We learn from the report submitted to the shareholders at the annual meeting on the 10th inst. at Montreal, that the Montreal Telegraph Company has not suffered so much as the directors expected from what they not inappropriately call "the disastrous times." The net profit for the year 1877 is 168,671 dols. 43 cts., and the number of messages sent over the lines of the company in 1877 showed an increase of 3,642. While the revenue has increased the expenditure has decreased. The balance-sheet of the company appears, on the whole, to be satisfactory.

It is satisfactory that, in spite of the universal depression of trade, there has been little decline in the value of railway property during the past year; and on the passenger lines there has, in some cases, been an improvement. Thus the Brighton dividend, which was 7¼ per cent. at this time last year, is 8¼ this, and the Metropolitan has risen to 5 per cent. Some of the other Companies, whose dividends have not, at the time we write, been declared, will, doubtless, be able to point to an equally pleasant result of the half-year's operations. No importance should be attached to the increase in the Great Eastern dividend, which had better have remained at 1½ per cent., and the South Eastern has not made progress.

We notice that a vigorous attempt is being made to frustrate the hopes of the promoters of the fusion of the South Eastern and Chatham and Dover Companies. It appears to us that the shareholders have a powerful reason for desiring the success of the Bill before Parliament, especially those of the Chatham Company. But if it can be shewn that the union of the Companies will be injurious to the interests of the public, the opposition will command and deserve encouragement. The fate of the Bill will be known before the close of February.

Sir Edward Watkin made a lame attempt the other day, at the half-yearly meeting of the proprietors of the Manchester and Sheffield Company, to defend his Board from the censure which had been visited upon them for allowing the negociations with the Great Northern and Midland Companies to fall through. According to Sir Edward, it was because the Midland Railway was included in the scheme that it came to nothing; an alliance with the Great Northern alone would have been advantageous. Perhaps it would—to the Sheffield Company. But the proprietors, though they did not say anything, must have felt that their Chairman was talking nonsense when he repeated the contention that the Sheffield Company was entitled to "an absolute 4 per cent guarantee." Possibly, Sir Edward; but people often think they are entitled to things and don't get them—because other people do not see through the same spectacles.

THE TELEGRAPHIC JOURNAL.

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TELEGRAPHIC FIRE ALARMS FOR LONDON.

The importance of telegraphy as a swift means of conveying warnings is every day receiving more and more attention. In France it has been recently applied to notify the approach of floods on canals, in Norway to acquaint the fishermen of the fiords with the whereabouts of the herring schools, in America it is doing valuable daily service as a foreteller of storms or weather changes, and in more countries than one it is being adopted in the great towns as an alarm in cases of fire. The advantages of a system of telegraphic fire alarms in a great city must be apparent to any one who bestows the least thought on the subject. In a town unprovided with such a system, the only mode of calling the fire-brigade is to run or drive to the nearest fire-brigade station. When the paralysing alarm and excitement of tenants in a burning house, their possible ignorance of the true position of the station, the proverbial delinquency of the public guardian, and the actual distance of the site of the fire from the station in question are taken into account, it will be seen that the ordinary plan of procuring help is at best a clumsy, slow, and imperfect one. With a proper system of fire-alarms, much agitation, blundering, and precious time may be saved. All the principal thoroughfares would be provided with street alarm posts, which would be as conspicuous and become as well-known as the street letter boxes. They would be situated at short and regular distances, say two hundred yards from each other, and would be accessible to the public by some simple means, such as the breaking of a protecting pane of glass. The mere pulling of a handle or pressing of a knob would then in an instant alarm the nearest brigade station, and indicate the position of the fire. In a few moments more some simple acknowledgment of his signal would be returned to him. If the fire were serious and urgent, he could let the fact be known by a further simple signal. All this could be done by the most ignorant person, and even by a child; but it would of course be most frequently the work of the district watchman. An ordinary telegraphic recording instrument could in addition be provided in the event of special communication being desirable between the fire-men and the station.

We all know that the growth of a fire proceeds in an accumulating ratio which far outstrips the compound interest law. A spark may kindle a great conflagration, but not all at once. In its early stages an outbreak of fire, though alarming, is weak, and may be readily extinguished; but it gathers strength and appetite by what it feeds on. At its beginning it is most vulnerable, but it is precisely this invaluable period which is frittered away and lost by the existing dilatory mode of alarm. While the messenger is hurrying on foot through, it may be, long and crowded thoroughfares to the Brigade Station, the fire is making good its hold, not only consuming more property, but rendering it a far more difficult, dangerous, and expensive task to get it out. Any saving of time during this incipient period is supremely important, and it is this saving which telegraphic alarms permit of. Their introduction would not only diminish the risk of life attending the fireman's work, the ravages of the fire, and the expense of extinguishing it, but they would be a convenience and a source of increased safety and security to the public.

The American's were quick to perceive the solid benefits of fire alarm systems, and many of their cities are provided with them. On the Continent recently, and in Glasgow, a like precaution has been adopted. Why then, we are tempted to ask, is London without such a system—London, in which, owing to its crowded streets and its masses of buildings, fire operations are difficult, and where the distance is sometimes as great as two miles between the nearest Brigade Station and the seat of the fire? Our London Fire Brigade is the admiration of all who have seen it at work, but in spite of its prompt and vigorous action, it is often taken at a disadvantage, and the daily papers are witness to the great loss of property, if not of life, which is caused by London fires.

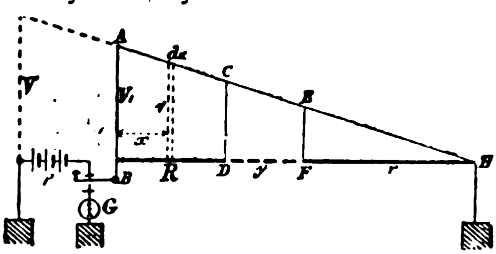
Is it due to an indiscriminating conservatism or to a stolid inertia, that the authorities have not taken steps to introduce fire-alarms? The advantages are so apparent that they must recommend themselves to all unbiassed persons; and if examples are wanted, we could not have a better variety than New York, Amsterdam, Paris, and Glasgow. It may, in fact, be taken for granted that our canny friends beyond the Tweed would not adopt any new-fangled concern rashly. The Scotch, however, have the shrewdness to examine and see for themselves, and the enterprising liberalism to promptly adopt a good thing when they find it. It is to be hoped that their example will quicken the Metropolitan Board of Works to bestir themselves in earnest about this matter. It is inevitable that a telegraphic system of fire-alarms for London must come sooner or later, and the authorities will earn our thanks if they hasten it as much as possible.

Public opinion will otherwise have to fall back on the far less satisfactory plan of forcing such a course upon them. We do not propose to deal here with the relative merits of different systems. Any system is better than none; but, after due investigation, let the best be chosen.

LOCALISATION OF A PARTIAL DISCONNECTION IN A SUBMARINE CABLE.

PARTIAL disconnection faults, although they are seldom met with in cables with gutta-percha cores, frequently occur in those whose insulating material is india-rubber. This arises from the elasticity of the substance; for when any undue strain is put on the core the conductor breaks, but the india-rubber only stretches, and an earth fault is not made. When the strain is taken off, the two ends of the conductor come together and make contact more or less perfectly. If the break is noticed at the moment the cable is being laid from the ship, its position is of course known. But in some cases a fault of this nature does not develop itself until some time after the submersion; its locality can then only be found by testing.

Such faults are difficult to localise, as none of the ordinary tests are applicable to them. The following method, however, is susceptible of considerable accuracy if carefully made.



In the fig. let R, r be the resistances of the portions of cable on either side of the fault, y being the resistance of the latter. Let ρ be the resistance of a battery normally connected to the cable by a discharge key, and let G be the resistance of a galvanometer, through which the cable can be discharged on the depression of the key.

Now, if the further end of the cable be to earth, and V be the potential of the battery when its poles are free, then V_1 will be the potential at the end B of the cable, and v will be the potential at a point distant x from B. And further, A B D C will represent the charge in the portion R of the cable, and B F G the charge in the portion r.

Now if the key is *instantaneously* depressed so as to put the cable in connection with the galvanometer, the charges in the cable will flow out at both ends.

Let $v.dx$ be a differential part of the charge A B D C, then this portion will split, and the portions flowing out at the two ends of the cable will be inversely proportional to the resistances on either side of it; thus the portion flowing out through G will be:

$$d\,Q' = v\,\frac{R + y + r - x}{G + R + y + r}\,dx.$$

Now

$$V_1 : v :: R + y + r : R + y + r - x,$$

therefore

$$v = V_1\,\frac{R + y + r - x}{R + y + r}$$

that is

$$d\,Q' = V_1\,\frac{(R + y + r - x)^2}{(G + R + y + r)\,(R + y + r)},$$

and the integral of this between the limits

$$x = R \text{ and } x = 0$$

will give the quantity Q′ flowing through the galvanometer, that is:

$$Q' = \int_0^R V_1\,\frac{(R + y + r - x)^2}{(G + R + y + r)\,(R + y + r)}\,dx$$

$$= \frac{V_1}{(G + R + y + r)\,(R + y + r)}\int_0^R (R + y + r - x)^2\,dx$$

$$= \frac{V_1}{(G + R + y + r)\,(R + y + r)}\left(\frac{(R + y + r)^3 - (y + r)^3}{3}\right)$$

$$= \frac{V_1 R}{3}\cdot\frac{R^2 + 3\,R\,(y + r) + 3\,(y + r)^2}{(G + R + y + r)\,(R + y + r)}.$$

Similarly we should find that the quantity Q″ flowing out from the portion r of the cable would be:

$$Q'' = \frac{V_1\,r^3}{3\,(G + R + y + r)\,(R + y + r)},$$

and therefore the total quantity Q flowing through the galvanometer will be

$$Q' + Q'' = \frac{V_1}{3}\cdot\frac{R\,(R^2 + 3\,R\,(y+r) + 3\,(y+r)^2) + r^3}{(G+R+y+r)\,(R+y+r)} \quad (1)$$

$= Q.$

Now

$$V : V_1 :: \rho + R + x + r : R + y + r$$

is

$$V_1 = \frac{V\,(R + y + r)}{\rho + R + x + r},$$

therefore

$$Q = \frac{V}{3}\cdot\frac{R\,(R^2 + 3\,R\,(y+r) + 3\,(y+r)^2) + r^3}{(G+R+y+r)\,(\rho+R+y+r)} \quad (2).$$

But the total quantity Q_1, which the cable would take if its end were insulated, would be

$$Q_1 = V\,(R + r),$$

or

$$V = \frac{Q_1}{R + r}.$$

Substituting then this value of V in equation (2) we get

$$Q = \frac{Q_1}{3\,(R+r)}\cdot\frac{R\,(R^2 + 3\,R\,(y+r) + 3\,(y+r)^2) + r^3}{(G+R+y+r)\,(\rho+R+y+r)}.$$

Let

$$R + r = L, \text{ therefore } r = L - R.$$

$$R + y + r = L_1, \text{ therefore } y + r = L_1 - R.$$

Substituting these values in the above equation we have

$$Q = \frac{Q_1}{3\,L}\cdot\frac{R\,(R^2 + 3\,R\,(L_1 - R) + 3\,(L_1 - R)^2) + (L - R)^3}{(G + L_1)\,(\rho + L_1)}$$

$$= \frac{Q_1}{3\,L}\cdot\frac{R^3 + 3\,L_1^2\,R - 3\,L_1\,R^2 + L^3 - 3\,L^2\,R + 3\,L\,R^2 - R^3}{(G + L_1)\,(\rho + L_1)}.$$

By multiplying up we have

$$\frac{3 Q L (G + L_1)(\rho + L_1)}{Q_1} = L^3 + 3 R (L_1^2 - L^2) - 3 R^2 (L_1 - L),$$

therefore

$$R^2 - R (L_1 + L) = - \frac{3 Q L (G + L_1)(\rho + L_1) - L^3 Q_1}{3 Q_1 (L_1 - L)},$$

therefore

$$R^2 - R (L_1 + L) + \left(\frac{L_1 + L}{2}\right)^2 = \left(\frac{L_1 + L}{2}\right)^2 - \frac{3 Q L (G + L_1)(\rho + L_1) - L^3 Q_1}{3 Q_1 (L_1 - L)},$$

that is

$$R = \frac{L_1 + L}{2} - \sqrt{\frac{(L_1 + L)^2}{4} - \frac{3 Q L (G + L_1)(\rho + L_1) - L^3 Q_1}{3 Q_1 (L_1 - L)}}.$$

For example:

The conductor-resistance L_1 of a submarine cable which had a partial disconnection in it, was 5,000 ohms. The conductor resistance L, when the cable was perfect, was 2,000 ohms. The discharge Q_1 from the cable, when the end was disconnected, was equal to 300; and the discharge Q, when the end was to earth, was equal to 60. The resistance of the battery ρ being 200 ohms, and of the galvanometer G, 100 ohms. What was the distance R of the fault from the end of the cable?

$$R = \frac{5000 + 2000}{2} - \sqrt{\frac{(5000 + 2000)^2}{4} - \frac{3 \times 60 \times 2000 \times (100 + 5000)(200 + 5000) - 2000^3 \times 300}{3 \times 300 \times (5000 - 2000)}} = 3500 - 3099 = 401 \text{ ohms.}$$

That is, the fault is 401 ohms distant from B.

The formula just given is only correct when the line is free from earth currents; but as this is seldom the case, a correction is necessary in order that the true value of R may be obtained.

Supposing that the electro-motive force of the earth current, whose strength we will call $\frac{V}{n}$, be taken to act in the same direction as the battery current, then at the moment before the key is depressed to take the discharge there will be in the cable, besides the quantity given by equation (2), a quantity q' due to the earth current; this will be

$$q' = \frac{V}{3n} \cdot \frac{R (R^2 + 3 R (y + r) + 3 (y + r)^2) + r^3}{(G + R + y + r)(\rho + R + y + r)};$$

but when the key has connected the cable to the galvanometer this quantity becomes changed to

$$q'' = \frac{V}{3n} \cdot \frac{R (R^2 + 3 R (y + r) + 3 (y + r)^2) + r^3}{(G + R + y + r)(G + R + y + r)};$$

therefore the quantity discharged due to the earth current will be

$$q' - q'' = \frac{V}{3n} \left\{ R (R^2 + 3 R (y + r) + 3 (y + r)^2) + r^3 \right\} \left\{ \frac{1}{(G + R + y + r)(\rho + R + y + r)} - \frac{1}{(G + R + y + r)(G + R + y + r)} \right\} = \frac{V}{3n} \cdot \frac{R (R^2 + 3 R (y + r) + 3 (y + r)^2) + r^3}{(G + R + y + r)(\rho + R + y + r)} \left(\frac{G - \rho}{G + R + y + r}\right)$$

and the total quantity discharged through the galvanometer will be

$$Q + q' - q'' = \frac{V}{3} \cdot \frac{R (R^2 + 3 R (y + r) + 3 (y + r)^2) + r^3}{(G + R + y + r)(\rho + R + y + r)} \left(1 + \frac{1}{n} \cdot \frac{G - \rho}{G + R + y + r}\right) = Q_2$$

or

$$Q_2 \frac{n (G + R + y + r)}{n (G + R + y + r) + G - \rho} = \frac{V}{3} \cdot \frac{R (R^2 + 3 R (y + r) + 3 (y + r)^2) + r^3}{(G + R + y + r)(\rho + R + y + r)} \ldots$$

From (2) and (3) then, we can see that

$$R = \frac{L_1 + L}{2} - \sqrt{\frac{(L_1 + L)^2}{2} - \frac{3 Q_2 L \frac{n (G + L_1)}{n (G + L_1) + G - \rho} (G + L_1)(\rho + L_1) - L^3 Q_1}{3 Q_1 (L_1 - L)}}.$$

If the earth current is in the opposite direction to the battery current, then n will be negative.

The throw of the galvanometer needle from which Q_2 is determined is due partly to the actual discharge and partly to the continued action of the earth current. If d is the observed throw, and d_1 the observed permanent deflection when the needle has come to rest, then

$$Q_2 = \sqrt{d^2 - 2 d d_1}.$$

(See TELEGRAPHIC JOURNAL, Aug. 15, 1876, page 222.)

For example:

In the first example if the earth current had been one-twentieth of the strength of the battery current, that is, if $n = 20$, and if the throw of the galvanometer needle was equal to 100 divisions (d), and the permanent deflection 18 divisions (d_1), then

$$Q_2 = \sqrt{100^2 - 2 \times 100 \times 18} = 80$$

and

$$\frac{n (G + L_1)}{n (G + L_1) + G - \rho} = \frac{20 \times 5100}{20 \times 5100 + 100 - 200} = \frac{1020}{1019}.$$

We then have

$$R = \frac{5000 + 2000}{2} - \sqrt{\frac{(5000 + 2000)^2}{4} - \frac{3 \times 80 \times 2000 \times \frac{1020}{1019} (100 + 5000)(200 + 5000) - 2000^3 \times 300}{3 \times 300 \times (5000 - 2000)}}$$

$$= 3500 - 2902 = 598 \text{ ohms.}$$

H. R. K.

TOMMASI'S TELEGRAPH APPARATUS FOR WORKING LONG SUBMARINE CABLES.

(*Continued from page* 49.)

When the current ceases to circulate in the electro-magnet *a* the armature *b* is brought back to its place by the counterweight *e*, which, in its turn, producing interruption of the current of the second local pile in the electro-magnet H, naturally brings the armature K back to its place.

It is evident that, inasmuch as the pieces composing the other interrupting relays are identical with those immediately above described, they must produce upon the electro-magnet I the same effect as these latter produce upon the electro-magnet H, from whence it results that when the armature M is attracted, the spur wheel O prints a blue dot upon the same strip of paper.

The two spur wheels L and O, the rotation of which is produced by the clock-work of the apparatus, each rub constantly against a pulley which dips into a trough always full of red ink for the one and of blue for the other.

Although the south pole of the small bar A is covered with platinum, and that the ends of the springs F and G are of gold, and although the current of the local pile which works the two interrupting relays is relatively weak (at most two elements, "Daniell"), the spark which must necessarily flash between the south pole of the small bar A and the ends of the springs F and G at each interruption of the electric current might be injurious to them.

It is precisely in order to avoid this that the armature *b* each time that it is attracted by the electro-magnet *a* automatically breaks the electric current between the spring *g* and the knob or stud *h*, by the aid of the fork *f* the aforesaid current being compelled to pass by *p, n, h, g, f, m,* to reach the electro-magnet *a*, from whence it issues by I and O to come back to the pile in passing by the spring F, the small bar A, and the fork B; the result is, that the interruption of the current taking place between the spring *g* and the nob *h*, the spark flashes between this knob and this spring instead of being produced between the small bar A and the springs F and G, for it will be well understood that the same manœuvre is repeated upon the other interrupting relay when the current comes back to the pile by the spring G, the small bar A, and the fork B.

The spark which flashes between the spring *g* and the knob *h* does not produce the inconveniences which it would have produced between the small bar A and the springs F and G—

1st. Because the contact between the spring *g* and the knob *h* is much more energetically established than between the small bar A and the springs F and G.

2nd. Because the pieces *g* and *h* not requiring to be delicately and exactly regulated like the pieces A, F, G, they may be easily cleaned from time to time.

When then the knob 1 is pressed there is produced upon the strip of paper a red dot followed by a blue one; when knob 2 is pressed two red dots are produced, each followed by a blue dot; when the knob 0 is pressed a blue dot is produced followed by a red one, and so on.

By the effect of the pieces T, U, V, W, as well as of the set screws, D, J, R, S, and by means of an ordinary interruptor and a third local pile, an electric striking work may be set at work at pleasure, which will sound a bell with each red and blue dot produced by the receiving apparatus upon the strip of paper.

In applying this system to communications by an an aerial wire, the receiver will, as previously stated, be ordinary "Morse" instrument, and there will only be a single interrupting relay (fig. 5) instead of two. In this case the piece A will close the circuit of the current of the local pile only when it touches the spring F, and the part played by the spring G will be limited to that of serving as stop to the small bar A at each reversal of the current, which will consequently produce no sign upon the strip of paper of the ordinary "Morse" instrument.

If it is preferred to use the "Morse" code, even in sending messages through submarine cables of very great length, the manipulator will have but two knobs or studs, the one producing upon the strip of paper a red dot followed by a blue one (combination which will represent conventionally a "dot"), and the other producing upon the strip of paper a blue dot followed by a red dot (a combination which will represent conventionally a "dash"), this "dot" and this "dash" referring to the "Morse" code; but it is more useful to produce the nine numbers and the zero. In this case the illimitable cyphers resulting therefrom may be interpreted conventionally, according to the following table, which represents the beginning of a dictionary to be drawn up expressly for this purpose.

Dictionary.

00, sign to indicate that the numbers which follow it are to be interpreted each for a word.

000, sign to indicate that the numbers which follow it should be grouped by two's, each group representing a letter.

0000, sign to indicate that the numbers following it should be considered as numerical numbers.

01,	sign	representing	a period or full stop .
010	"	"	a comma ,
011	"	"	a colon :
0100	"	"	a semicolon ;
0101	"	"	a note of exclamation !
0110	"	"	interrogation ?
0111	"	"	a hyphen -
001	"	"	a parenthesis ( )
0010	"	"	per-centage °/₀

0011, sign to indicate that the word which follows it is underlined.

0	represents	0	24	represents	K
1	"	1	25	"	L
2	"	2	26	"	M
3	"	3	27	"	N
4	"	4	28	"	O
5	"	5	29	"	P
6	"	6	30	"	Q
7	"	7	31	"	R
8	"	8	32	"	S
9	"	9	33	"	T
10	"	A	34	"	U
11	"	B	35	"	V
12	"	C	36	"	W
13	"	Ç	37	"	X
14	"	D	38	"	Y
15	"	E	39	"	Z
16	"	É	40	"	a purchase.
17	"	È	41	"	purchases.
18	"	F	42	"	I buy.
19	"	G	43	"	you buy,
20	"	H	44	"	I will buy.
21	"	I	45	"	you will buy.
22	"	Ï	46	"	he buys.
23	"	J	47	"	they buy.
			48	"	will you buy?

As will be seen by the preceding table there may be producd without exceeding the use of five figures, 99999 combinations, that is to say, twice as many as are required to express all the words and all the tenses of all the verbs used, not only in the language of commerce, but in ordinary language.

At each end of the line a staff of translators would be provided to reduce into figures the dispatches written in ordinary letters, and, if required, to translate into ordinary language the dispatches received in ciphers.

The dictionary, of which the above table may give an idea, would be drawn up in several languages, care being taken that the same cipher represents the same word and the same tense and person of the same verb in all these languages, according to the desire of the sender, so that his dispatch would be delivered at its destination either in ciphers or translated into the language which the sender would himself indicate.

A SIMPLE ELECTROSCOPE.

M. Rameaux lately brought before the Société des Sciences of Nancy a very simple and sensitive electroscope. It consists of a fine fibre of white silk, fixed at one end by means of a little wax to any support, and free to oscillate in any direction under its point of attachment.

A single thread would, of course, suffice for the ordinary purposes of electroscopy properly so called, but it is preferable to employ two near each other, taking care to space them so that they cannot foul each other during their swing, or influence each other reciprocally.

One of the threads is charged to strong repulsions by means of a glass rod charged with positive electricity; the other is charged in a similar manner with a stick of resin charged with negative electricity. Every body which attracts one of the threads so charged, and repels the other, is necessarily electrified. Its electricity is of the same sign as that of the thread which it repels.

The sensibility of these electroscopes is greater, within certain limits, as the threads are made finer, longer, and less conducting.

If the finest sewing silk of commerce be untwisted, each of the parts or strands obtained will make an excellent electroscopic pendulum, which, if about sixty centimetres long, is very handy, and suffices for almost all tests. White silk is preferable to coloured.

The motions of these threads, if well charged, are very considerable, even when the bodies presented to them contain but slight charges of electricity. When the threads are not excessively fine, disturbances of the air do not destroy the observations so much as might be supposed. In the first place, these disturbances can be almost entirely removed; and, furthermore, the threads, even when agitated, obey so well any electric attractions and repulsions that it is absolutely impossible to mistake or detract from their evidence.

M. Rameaux has found this arrangement in all cases more sensitive and sure than a carefully-constructed gold-leaf electroscope, which he used for comparison.

This system also recommends itself in several ways, for instance:

1. It is so simple that every one can construct and use it.

2. It costs nothing; no special support being necessary. The threads can be fixed to any projecting piece, as the edge of a table; the only condition being that they may hang freely.

3. It can be set up in a moment, and consequently is at once ready for any unexpected requirement; whereas a gold-leaf electroscope long unused requires to be dried for hours.

4. It works perfectly, whatever the hygrometric state of the atmosphere.

5. It can be employed to show electric phenomena to a numerous auditory. With long, thin fibres and highly electrified bodies, the experiments are very telling.—*Bulletin de l'Association Scientifique de France.*

ANTOINE CESAR BECQUEREL.

During the last month France lost two of her most famous physicists, the elder Becquerel and Victor Regnault. Becquerel died on January 18th, and was buried on the 21st; Regnault died on the 19th, and was buried on the 22nd. From his long series of electrical researches it is in Becquerel that electricians are chiefly interested. He was born at Chatillon-sur-Loing, in the department of Loiret, on March 7, 1788. He was educated at the Polytechnic School, Paris, and on leaving it in 1808, he began life as a soldier by becoming an officer of the Imperial Engineer Corps. He passed at once to active service in Spain, under General Luchet, and was present at the Valencia, Lagonte, Torbosa, and at the taking of Tarragona, where he commanded a column of attack. He afterwards received the rank of captain, and took part in the campaign of 1814. At its close he was rewarded for his remarkable ability and valuable services by receiving the rank of *Chef d' Batallion* and the Cross of the Legion of Honour from Napoleon's own hands. In the peace of 1815 he quitted the army, and resolved thenceforth to devote himself to the pursuit of physical and chemical science, towards which he felt himself impelled by nature and inclination. He became a teacher, and afterwards, in 1837, a Professor of Physics in the Museum of Natural History, Paris, a post which he retained until his death. During the course of his long scientific career, Becquerel has made some valuable researches in meteorological and geological science, especially in the composition of minerals, and the influence of climates on forests; but the great body of his work has been done in the field of electricity and magnetism. He was the first to explain the part played by chemical action in the voltaic cell, and to show that electricity was disengaged in all chemical actions, and particularly in the case of acids acting on metals; the positive electricity appearing on the acid, the negative on the metal. He is also claimed to have been the inventor of the double liquid cell, with porous partitions of clay or membrane.

Electro-chemistry, of which he may be almost said to be the father, was always his favourite field of research. In 1834 he made his crowning discovery

of the electro-chemical deposition of metals by observing that when the two poles of a battery were introduced into solutions of metallic salts a layer of metal was deposited on the negative pole. This discovery, which is the basis of the galvano-plastic art was soon turned to account by De la Rive, of Geneva, who founded upon it his process of electro-gilding in 1840.

Becquerel decomposed, by means of an ingenious reducing cell, known as the *oxygen circuit*, a great variety of minerals, and built up others. Some of his discoveries have been applied to the practical treatment of silver, copper, and lead ores, and to the extraction of the salts of potash from bitter waters.

In thermo-electricity he made a great number of experiments on the currents generated by unequal heating of a single metal, and of two metals in contact, and tabulated the well-known thermo-electric series. These studies led him to the invention of an electro-thermometer, by which the temperature of unattainable places, such as the interior of animal and vegetable bodies, heights in the air, or depths underground, could be registered. Among other inventions of his may be mentioned the differential galvanometer, and an electro-magnetic balance.

In pyro-electricity he found that the property of becoming electric under simple pressure is not exclusively confined to Iceland spar, as, Haing had supposed, but belongs, in greater or less degree, to all bodies. His study of the conditions under which tourmaline shows electric polarity, according as the temperature rises, or falls, or remains constant, is a piece of research which has become classic.

Becquerel was a most indefatigable worker, and made many scattered investigations. Wherever observation or thought invited it, he directed his research. There is consequently a great variety and discursiveness about his results; but at the same time they are pregnant and suggestive.

By means of very delicate apparatus he demonstrated the generation of feeble electric currents in many of the operations of life. He proved the effects of electricity on the colour of flowers to be due to a mechanical bursting of the cells containing the dye, and not to a chemical change. The heating of bad conductors under the influence of the current, and the conductivity of different substances, also formed the subjects of various experiments. During the last ten years he was entirely engaged in studying a remarkable electro-capillary phenomenon observed by him in 1867. A good example of this phenomenon is obtained by immersing a cracked test tube, containing a solution of sulphate of copper in a solution of sodic sulphide; metallic copper is at once deposited in the crack. He found a similar action to take place with many other solutions, and partially enunciated the laws of the process. This investigation is Becquerel's unfinished labour; and small as it appears, it gathers importance in our eyes when we learn that he regarded it as likely to explain the deposition of metal veins in rocks and many physiological reactions which take place in vegetable and animal tissues.

Becquerel was a productive writer as well as an experimentalist. His greatest work is his *Traité Experimental de l'Electricité et du Magnetisme et de leurs Phénomènes Naturels*, in seven volumes, 1834-40. This was followed by three other electrical works, the *Elements d'Electro-chimie appliquée aux Sciences Naturelles et aux Arts*, 1843; the *Traité d'Electricité et du Magnetisme, leurs Applications aux Sciences Physiques, aux Arts, et à l'Industrie*, 3 vols., 1856; and the *Résumé de l'Histoire de l'Electricité et du Magnetisme*, 1858. He was also the author of several treatises on physics, chemistry, meteorology, and numerous scattered memoirs. These are chiefly to be found in the *Comptes Rendus*, and the *Annales de Chimie et Physique*.

He was a member of the Institute of France, a corresponding member of the Royal Society of London, and of the Berlin Academy of Science. He received the Copley Medal from the Royal Society several years ago, and was decorated with the Cross of Commander of the Legion of Honour by Napoleon III., and the Grand Cross of the Order of the Rose by the Emperor of Brazil.

Despite a health apparently feeble, and a frame by no means robust, Becquerel continued active to the advanced age of ninety years, sustained by moral energy and strength of will. His love for work, his keen interest in natural phenomena, and his zeal for research never flagged; while the charming vivacity of his manner continued to the last. He leaves behind him a son, Edmond Becquerel, Professor of Physics in the *Conservatoire des Arts et Métrers*, who has for many years been his father's assistant, and who has proved himself worthy to perpetuate his father's fame.

SAUNDERS *versus* THE POSTMASTER-GENERAL.

AN appeal came before Lords Justices Bramwell, Brett, and Cotton, in the Appeal Court, a few days ago, on a question of compensation payable by the Government to the persons employed by the telegraph companies whose business was transferred to the Post Office under the Electric Telegraph Acts of 1868. It was taken as a representative case bearing on many others and involving an amount of about £20,000. The Act in question empowered the Postmaster-General in purchasing the telegraphs to allow compensation to the clerks of the companies whose services were not retained. In the present case, Mr. John Saunders, who was a district inspector of the Electric and International Telegraph Company, requested the Postmaster-General to assess the compensation he was to receive on the basis of his last year's salary, and the amount paid to him as expenses. The Postmaster-General, however, declined to take the expenses into account, on the ground that they did not form part of the prosecutor's annual salary. Mr. Saunders accordingly applied for a mandamus, and the Lord Chief Justice and Mr. Justice Field, in the Queen's Bench Division, gave judgment in his favour. Against this decision the Postmaster-General now appealed. After hearing the arguments for the Postmaster-General, their lordships, without calling on the other side, were of opinion that the compensation to Mr. Saunders should have been based, not upon his salary alone, but also on what he could save out of the allowance made to him for expenses. They accordingly gave judgment for the prosecutor, and dismissed the appeal.

THE ROYAL INSTITUTION.

The Friday evening lecture at this Institution on February 1st, was delivered by Mr. W. H. Preece, the subject being "The Telephone." The lecture-hall was crowded to excess, a large number of visitors being unable to obtain admission.

Mr. Preece in commencing his discourse defined the telephone to be an instrument constructed for the transmission of sound to a distance. The art of conveying sound to a distance is as old as the ancient Sphynx. That marvellous people the Greeks practised it; and doubtless it has served to inspire awe in many a poor pagan of simple faith as he reverently kneeled before his idol of stone or of bronze. The earliest authentic account within the historical period of science of the germ of the telephone was shadowed forth by Robert Hooke in 1667, who said:—

"'Tis not impossible to hear a whisper at a furlong's distance, it having been already done; and perhaps the nature of the thing would not make it more impossible, though that furlong should be ten times multiply'd. And though some famous Authors have affirm'd it impossible to hear through the thinnest plate of Muscovy glass; yet I know a way, by which 'tis easie enough to hear one speak through a wall a yard thick. It has not yet been thoroughly examin'd how far Otacousticons may be improv'd, nor what other wayes there may be of quickning our hearing, or conveying sound through other bodies than the Air: for that that is not the only medium I can assure the Reader, that I have, by the help of a distended wire, propagated the sound to a very considerable distance in an instant, or with as seemingly quick a motion as that of light, at least incomparably quicker than that which at the same time was propagated through the Air; and this not only in a straight line, or direct, but in one bended in many angles."

This fancy remained an idea until 1819, when Wheatstone produced his "magic lyre," an arrangement in which sounds were transmitted along a deal rod to whose further end a sounding board was attached. This was the first telephone, and was the precursor of those elegant toy-telephones which are now sold in the streets for a penny.

Mr. Preece then explained the elementary principles of sonorous vibrations, viz., pitch, loudness, and clang-tint, and showed how air-vibrations, in the form of articulate speech, can be actually recorded on paper by Barlow's logograph. The experiments of Page, Gray, Bell, Varley, and Edison, in which sound is produced by electrical vibration, were next alluded to and explained. A very elegant experiment, arranged by Mr. Edmunds, showing how sonorous vibrations can be made to transmit currents of electricity varying in number according to the pitch of note, was then shown. The experiment consisted in placing a Reiss' telephonic transmitter on the current of the primary wire of an inductorium, the secondary wire of which was connected to a rotating vacuum tube; the variation in the rate at which the contacts were made and broken in the transmitter when notes were sounded, or words spoken into it, produced marked effects in the discharge taking place through the tubes. After giving details of the musical telephones of Reiss, Gray, and Edison, and explaining that such instruments could only reproduce the pitch of a note, Mr. Preece showed how the movement of the iron diaphragm in a Bell's telephone produced currents of electricity, a Thomson's galvanometer being employed for the purpose; on any depression of the diaphragm a distinct deflection on the scale was produced. The exact construction of the Bell telephone was then shown by putting together the several parts of which it is composed. By means of wires carried from the Institution to Long's Hotel in Bond Street, the notes of a bugle played at the latter place were distinctly heard by the audience several yards distant from telephones placed at various points of the lecture-hall. Conversations were also carried on between the hall and the hotel.

At the latter part of his lecture, Mr. Preece introduced, for the first time in England, Edison's "Phonograph," an illustration of which we gave in the January 1st number of this Journal. The exhibition of this instrument, of which so much has been heard, produced quite a sensation amongst the crowded audience—a sensation which culminated in loud and continued applause when a sentence spoken into the mouthpiece of the apparatus was reproduced, by turning the handle, in tones sufficiently distinct to be heard all over the hall.

In speaking of the instrument, Mr. Preece remarked: Mr. T. A. Edison, of New York, has crystallised into a fact the ideal of the poet who longed "for the sound of a voice that is still."

The phonograph is but the outcome of the articulating telephone, and though several have added their share in perfecting the "farspeaker," there is no name in connection with it that will shine with greater brilliancy than that of Alexander Graham Bell. His father's occupation of a vocal physiologist led him to study the vocal organs and the production of sound. Helmholtz's researches led him to investigate electricity and its application to telegraphy. The desire to increase the capacity of wires for the conveyance of messages led him to devise systems of multiplex telegraphy and this by steady and sensible degrees led him to articulate telephony. We have here a notable example of the modern method of research where imagination suggests experiment, and experiment by evolution produces growth and perfection. Things that are new are not always accepted as true. The accounts of the telephone were received in this country with great scepticism. Many even now doubt its truth until they actually test its reality. When once, however, a new thing is shown to be true, a host of detractors delight in proving that it is not new. The inventor has to pass through the ordeal of abuse. He is shown to be a plagiarist or a purloiner, or something worse. Others are instanced as having done the same thing years ago, though perhaps their own existence, apart from their ideas, have never been before heard of. Professor Bell will have to go through all this; nevertheless, his telephone will always be associated with his name, and it will remain one of the marvels of this marvellous age, while its chief marvel will be its beautiful and exquisite simplicity.

Notes.

Telephoniana.—A letter from Mr. W. J. Millar, C.E., of Glasgow, recently appeared in two of our contemporaries, announcing the somewhat startling discovery that Mr. Millar had succeeded in constructing a telepone which operated without the agency of magnetism. Shrewd people suspected that this was nothing more than a re-discovery of the pill-box telephone well-known to Macaulay's schoolboy; but so many mysterious things have been told of this uncanny instrument, that cautious people have been looking for further intelligence about the matter. It now appears that although the principle is the purely mechanical principle of the pill-box contrivance, it has been so well applied by Mr. Millar, that conversation, pianoforte music, and songs are transmitted over a wire about fifty yards long with great distinctness. The wire may be bent round the angles of a house without interfering with the vibrations. A great deal depends on the way in which the wire is fitted up, its quality, and the adaptation of the mouth-piece and disc. Next to inventing an instrument on a new principle is the practical improvement of one already known, and Mr. Millar will do good service if he succeeds in lifting, what has hitherto been regarded as a child's toy, to the level of an appliance useful in the business of life.

We believe that telephonic communication between the offices of the *Times* and *Daily News* and the House of Commons, is now established.

Successful speaking has also been carried on between Wick and Kirkwall over the Pentland Firth Cable.

The Telephone in Germany.—Dr. Stephan, the Director-General of Postal Telegraphs, North Germany, has issued printed instructions as to the use of the telephone. Special offices in connection with the ordinary telegraph office will be opened for telephonic messages. When a telephonic message is to be sent, the telephone office will request the other office to connect up for telephone sending. The sender is enjoined to speak slowly, clearly, and without forcing the voice, the syllables being carefully separated and all accurately pronounced. A pause is to be made after each word to allow the receiving operator to write it down. The latter verifies the number of words sent and rapidly repeats the message as he received it for correction. To ensure secrecy, the telephones are kept in a private office, and the operators are forbidden to disclose the names of the parties to the message. The charge is fixed at so much per word as in ordinary messages.

We prophesied (says the *Scientific American*), even better than we knew the other day, when we said that the adoption of so short a name as "Fernsprecher" for the telephone by the Germans was a matter for congratulation, because they would otherwise soon find a way of smothering it under some frightfully polysyllabic title. To shew how closely the fortunate instrument has escaped this fate, a correspondent in Heidelberg, writes us that no less than fifty-four names were proposed in German, all of varying degrees of length and atrocity. Some (we will not inflict the reader with the original titles) signified "mile tongue," "kilometre tongue," "speaking post," "word lightning," "world trumpet," and finally one inventor, collecting all his energies for a grand effort, triumphantly produced "doppelstahlblechsungensprecher."

Our contemporary adds a useful hint to the effect that the jaw can be replaced by pressing on the lower molars with the fingers, and guiding the muscles with the thumbs.

The French Academy of Sciences propose to award the Marshal Vaillant prize in 1879 for the best solution of the problem—to perfect the phonetic telegraph in some important point. The sum bequeathed in 1873 by the Marshal Vaillant to found the prize was forty thousand francs, and the Academy have decided to offer the prize every two years.

Telephones are being sold at 3s. each in Vienna. We hear that over 5,000 telephones have now been made for Messrs. Bell and Reynolds by the Silvertown Telegraph Company.

Resistance of Horn Carbon.—M. Salet has found that horn carbon gives far greater variations of electric resistance under pressure than graphite, and it is expected that it will therefore take the place of the latter in telephones constructed on Mr. Edison's principle.

It is proposed to erect a monument to the memory of Ruhmkorff, who, although a Hanoverian by birth, is regarded as a Frenchman by the French people, inasmuch as his powers were developed in France.

The Electric Light at the Paris Exhibition.—The machinery for producing a powerful electric light is being installed on the bridge of Concord, Paris. The light is intended to illuminate all that part of the Seine about the bridge, and the whole front of the Palace of the Trocadéro.

M. Chikoleff, of St. Petersburg, by a series of experiments for the Russian War Office, confirms the results of the recent South Foreland trials of magneto-electric machines, and recommends the electro-deposit of copper on the carbons.

An exhibition of new inventions has been opened in the Palais de l'Industrie, Paris. It is purposed to continue it annually, and it promises to be popular and commercially successful.

An ingenious pen, penholder, and inkstand combined, has been brought out by Messrs. Letts & Co., of diary celebrity. It contains a supply of ink for about two months, can be recharged when exhausted, and is not larger than the ordinary pocket penholder.

APPLICATION OF THE TELEGRAPH TO THE HERRING FISHERY.—During the fishing season the herring schools enter the fiords of Norway at quite unexpected times, and at places where there are often only one or two fishing boats, and it frequently happens that before the neighbouring boats can be warned, the herrings have deposited their spawn, and returned again to the open sea. To prevent these oft repeated disappointments, and the losses which result from them to the fishers, the Norwegian Government has established over a length of 200 kilometres of the coast frequented by the herrings, a submarine cable, with land stations, at intervals sufficiently close and communicating with the fishing village. When the school of herrings is perceived in the offing, and it can always be recognised at a certain distance by the ripple which it raises, a telegraphic message, sent along the coast, announces to each village the fiord or bay into which the herrings have penetrated.—*Count du Moncel.*

IN Paris, the merchants and clubs now have an instrumental delivery of all political, market, bourse and general intelligence on printed slips direct, and without any delay whatever, through the medium of the Havas agency. This is a great improvement on the system now in use in London clubs, and should be adopted in them at once. Perhaps the Exchange Telegraph Company will take steps to see it carried out.

THE Bahia-Rio Janeiro Cable is interrupted and messages will be forwarded to Rio by steamers leaving Bahia. The enforced delay of messages will thus be about three days.

TELEGRAPHIC TARIFF IN FRANCE.—A bill has been presented to the French Chambers to effect the reduction of the rate charged for messages throughout France to 5 centimes or ½d. per word, with a minimum of 50 centimes or 5d. for any message. The present minimum is 60 centimes in Paris, and 140 centimes throughout France per 20 words. To provide for the probable increase of correspondence due to such a reduction of charge, a supplementary credit of 3,309,810 francs would be opened, 949,810 francs of which being destined for the *personnel*, and 2,369,000 for material and new works.

A NEW AMERICAN TELEGRAPH Company.—The "Continental Telegraph Company" has been formed in New York by parties who have been prominently connected with the Atlantic and Pacific Company. The capital is placed at 10,000,000 dollars. Right of way through New Jersey has been obtained for the new line to Philadelphia and Washington, and the works have already been commenced. The first line will run from New York to Philadelphia, and will consist of five wires, the size of the wire being No. 6, with poles 30 feet in height and 7 inches in diameter at the top; 40 poles to the mile. The second line will run from New York to Baltimore and Washington, and will also consist of five wires. Business will probably be opened about the first of April next. One of the new features to be introduced will be a combination of the Morse instruments and the telephone. Lines will be extended only to points where the amount of business will warrant them, and the best of materials will be used in construction.

DR. KERR'S EXPERIMENT.—The following experiment made in Berlin by Mr. J. Mackenzie at the instance of Helmholtz is given in the *Poggendorf's Annalen*, No. 11. A glass plate 12 millimetres thick, coated on opposite sides with tin foil, is supported and covered with larger glass plates. The foil is connected to the poles of a Holtz machine, or a Ruhmkorff coil. The glass plate is placed between two Nicol's prisms, as in Dr. Kerr's famous experiment, and a beam from a lamp sent through the polarising arrangement. When the foil was charged by the machine or coil, no increase of brightness was perceptible, even when polarised sunlight was employed instead of the beam from a lamp, or when a mica leaf, yielding the violet tint, was interposed between the glass plate and analyser. Experiments with oil of turpentine in place of glass also gave no positive results. Its is therefore concluded that Dr. Kerr's result is only due to electrification, in a secondary sense, through the heating effect it produces. It may be remembered that the maximum effect in Dr. Kerr's experiment was only obtained thirty seconds after putting on the current, and that the phenomenon disappeared as slowly on breaking circuit.

CIRCULAR MAGNET.—M. Duter recently exhibited, at a meeting of the French Physical Society, some circular steel discs, which he had magnetised by applying the pointed poles of an electro-magnet to their centre. In these magnets the neutral line between the north and south poles is a circle concentric with the circumference of the disc, and the quantities of north and south magnetism are equal on opposite sides of this equator.

THE DIFFERENCE OF POTENTIAL produced by the passage of water in capillary tubes, has been the subject of recent experiments by M. Haga, and by Mr. J. W. Clark, in Germany. For an account of them see *Poggendorff's Annalen*, No. 11, 1877. In each set of experiments a quadrant electrometer was employed to measure the difference of potential or electro-motive force generated. According to M. Haga, this difference is proportional to the pressure, and increases with the resistance of the water, and probably also with the temperature. It is also believed by him to be independent of the length of the tubes, but dependent on the nature of the inner surfaces. Mr. Clark is of opinion in very narrow tubes, the difference of potential is independent of the length, but in wider tubes it decreases with the length. He also finds that the narrower the bore of the tube the greater is the difference of

potentials produced when a liquid, as water, is forced through it; that the difference depends on the substance forming the interior of the tube, and that the seat of the electro-motive force produced is the surface of the liquid, and the inner wall of the tube. The original difference of potentials decreases with time, but may be restored on cleaning the tube with sulphuric acid and distilled water.

Dimensions of Lightning Rods.—The following results are published by Dr. Nippoldt of the Observatory of Paris. The existing errors with regard to the proper dimensions of lightning-rods are traceable to Kuhn's *Encyclopedia of Physics*, which gives the thickness for a conductor of iron 64 feet long as half an inch, and states that for other metals, such as copper or lead, the section ought to be proportional to the resistance of the metal.

The lightning conductor ought to fulfil two conditions:

1. To draw the current to earth.

2. To have sufficient sectional area to lead away the discharge without an injurious rise in temperature.

The elevation in temperature depends on the intensity of the current and the conductivity of the rod. Let W be the heat developed, J the intensity of the current, R the resistance of the rod; then

$$W = J^2 R. \quad (1)$$

Again, let l be the length of the conductor, g the cross-section to be found, s the density of the conductor, w its specific heat, r its specific resistance, M its mass, and t the temperature; then from the electrodynamic law it follows that

$$R = \frac{l}{g}\, r \quad (2)$$

and

$$W = J^2 . \frac{l}{g}\, r \quad (3)$$

and the mass M, which receives the total heat W, is raised to the temperature

$$t = \frac{W}{Mw} \quad (4)$$

and as $M = lgs$, by substituting this value in equation 4, we have

$$t = \frac{W}{lgsw.} = \frac{J^2 . r}{g^2 sw} \quad (5)$$

Temperature is independent of the length of the rod. The four metals employed as lightning conductors are

Metal.	Specific Heat.	Density.	Resistance.
Iron	0·1138	7·75	0·0986
Copper	0·0951	8·95	0·0162
Lead	0·0314	11·35	0·0199
Platinum	0·0324	21·54	0·0918

An iron conductor of 144 square millimetres ought therefore to be equalled by a copper conductor of 90 square mm., by a lead one of 320, and a platinum one of 156. M. Kuhn's gives the corresponding dimensions as 24 for copper, 230 for lead, 134 for platinum.

The resistance of copper (0·0162) given above is on the supposition that the metal is chemically pure. According to Dr. Mathiessen, the resistance is tripled if the metal contains ½ per cent. of iron. It is necessary to use copper containing not more than 2 per cent. of iron, and giving only one-fifth of the resistance of iron—that is, 0·0197 resistance instead of 0·0162.

The end of the rod should terminate in a platinum point two or three millimetres thick, having from three to seven square millimetres of section. A platinum point of this size will be heated from 2,000 to 500 times more than the rod itself, and if the passage of the current raises the temperature of the rod only 4° C. the platinum point will melt.

Electric After-currents in Iron Rods.—It was discovered by Villari that if a rod of iron or steel through which a current has passed be agitated, an after-current is again set up in the same direction as the original current. He explained the phenomenon on the hypothesis that the rod is transversely magnetised by the current, and employing Ampere's theory of molecular currents, that these currents arrange themselves in concentric circles round the axis of the rod. Now, when the rod is agitated after the interruption of the current, the molecular magnets tend to mingle themselves irregularly again, and in doing so generate an induction current called by Villari an "agitation current." Prof. H. Streintz, at the Royal Academy of Sciences of Vienna, has recently, shown how to calculate the magnetic force exerted on the molecular currents by the original current in the rod. The problem is a case of Biot and Savart's theorem, that a rectilineal current of infinite length acts upon a pole of a magnet with a force inversely proportional to the perpendicular distance of the pole from the conductor. In the case in question we have to calculate the action of a circular surface (the rod being cylindrical) with uniform mass upon a mass-point situated in the surface. But a circular line with uniform mass exerts no action on a point situated in the enclosed surface, while it acts on an external point in the same plane as if the mass of the circle were collected in the centre. Therefore the force exerted upon a magnetic pole situated at the distance r from the axis, $p = \frac{k\, r}{a^2}$, in which k is a constant, and a the semi-diameter of the rod. The total moment upon all the molecular magnets contained in the rod is then $R = K\, l\, a$ where K is a constant and l is the length of the rod.

The length of the recently-opened line to Western Australia, from Adelaide to Perth, is 2,046 miles; and when it is considered that the greater part of the country thus traversed is a sandy, waterless track, it will be seen that the undertaking evinces no little pluck and pains on the part of both South and Western Australia.

POST OFFICE TELEGRAPHS.—The revenue of the Post Office Telegraphs for the year ended the 31st day of March, 1877, amounted to £1,328,315, from which £1,120,211 had to be taken for salaries, wages, maintenance, &c., and £13,290 as a contribution to a depreciation fund to replace submarine cables. This left a balance of profit of £194,814, equal to 1·97 per cent. on a capital of £9,845,278.

THE Western and Brazilian Telegraph Company, Limited, intimate that the s.s. *Calabria*, belonging to the Telegraph Construction and Maintenance Company, Limited, sailed on the 10th inst. for Maranham, with cable for the purpose of putting Maranham and Pernambuco in telegraphic communication and replacing the portion lost in the *Hibernia*.

Patents.

251. "Improvements in electric telegraph conductors and apparatus for their manufacture."—C. W. SIEMENS, Jan. 19.

275. "An arrangement of semi-automatic apparatus for transmitting telegraph messages by the Morse system."—T. J. SMITH (communicated by M. le Comte E. Liccardi), Jan. 21.

291. "Apparatus for communicating signals in connection with electric telephones."—J. H. MCLURE, Jan. 23.

307. "Telephones."—D. PIDGEON, Jan. 23.

308. "Galvanometers and relay apparatus for electric telegraph purposes."—L. A. BRASSEUR, S. W. M. de Sussex, Jan. 23.

312. "Improvements in the manufacture of submarine telegraph cables, whereby their gutta-percha or other insulated cores are protected from the ravages of insects."—N. CLIFFORD, Jan. 23.

324. "Improvements in medical galvanic apparatus applicable to the human body."—B. SCARLES, Jan. 24.

333. "Improvements in controlling time-keepers by electricity, and in apparatus therefor."—F. J. RITCHIE, Jan. 25.

375. "Improvements in the manufacture of insulated telegraphic conductors, and of insulating materials to be employed therein, which materials are also applicable to other purposes."—E. T. TRUMAN, Jan. 29.

405. "Improved apparatus for reproducing musical and other sounds by electricity."—A. M. CLARKE (communicated by C. L. Weyher), Jan. 30.

408. "Improvements in means and apparatus for controlling and localising electric currents for the transmission of electric signals and messages."—Z de BEJARY O'LAWLOR, Jan. 31.

446. "An improvement in illuminating objects to be photographed, and the interior of public and other buildings."—H. V. WEYDE, Feb. 2.

471. "Manufacture of carbon electrodes."—M. GRAY (communicated by N. E. Reynier), Feb. 5.

491. "Improvements in apparatus for transmitting and indicating signals and orders, parts of which improvements are applicable as a new mechanical motion to other useful purposes."—H. F. JOEL, Feb. 6.

492. "New or improved battery rheostats, specially applicable for medicinal purposes."—S. J. COXETER, Feb. 6.

ABSTRACTS OF SPECIFICATIONS.

430. "Improvements in Electric Telegraphs."—A communication from J. J. ETIENNE LE NOIR, Paris, dated, Feb. 1, 1877. 6d. This relates to writing or copying telegraphs, and includes an improved governor for enabling the sending and receiving styles to keep synchronous in their action. When the speed of the governor is too high the arms fly apart, and establish a circuit which subjects the spindle to electro-magnetic resistance. In order quickly to "discharge," or "empty" the line, a reverse pole of feeble tension is applied to the line in place of earth. The message is written in non-conducting ink, upon metallic paper, wound round a cylinder, and is transmitted by the passage of a style across the paper. It is received by a style or marker on white paper, the style being actuated by electro-magnetism produced by the line currents.

492. "An improved apparatus for generating electricity and motive power."—PAUL JABLOCHKOFF, Paris, dated Feb. 5, 1877. 6d. This consists in a novel form of voltaic battery, in which the current is produced by the reaction of fused nitrates upon carbonaceous matter, the latter constituting the negative pole, and the former the positive pole. The gas generated by the action of the cell are utilised as a source of motive power by conducting them in a closed pipe from the cell to a reservoir. These gases are similar in their nature to those produced by the explosion of gunpowder.

515. "Improvements in telegraph posts, and in the method of fixing the same."—J. M. NERMAN, dated, Feb. 7, 1877. 4d. This consists in forming light and strong telegraph posts by driving two uprights of angle or trough iron into the ground, a short distance apart, and tying them together at the top by cross bars, perforated with holes for the reception of insulators. In soft ground, the base of the poles in the hole is filled round with concrete, cement, or asphalt.

522. "An improvement or improvements in fixing the insulators of electric telegraphs."—J. H. CORDEAUX, Feb. 7, 1877. 6d. By this plan the bolt supporting the insulator is formed with a screw thread at its end, and screws into the insulator, a washer of india-rubber or other yielding material being placed on the screwed end of the bolt so as to be compressed between the insulator and the shoulder on the bolt, when the insulator is screwed home. This serves to keep the insulator tightly on. The insulator may be readily removed by unscrewing.

653. "Improvements in electric bell and thief-detector."—A. G. STOCKWELL, dated Feb. 17, 1877. 6d. The object of this invention is to save the time and inconvenience necessary for readjusting the indicators now used, to give a longer action to a self-adjusting indicator, and to indicate which part of the house is being entered by burglars. The closing of a circuit is made to attract a pendulum, which rings the alarm bell, and by its subsequent oscillation, on being freed, indicates the quarter of the house the alarm comes from.

691. "Improvements in Electric Telegraphs."—J. C. L. LOEFFLER and R. W. N. P. HIGGS, dated Feb. 20, 1877. 1s. This consists in a means of overcoming the retardation of signals on submarine cables, arranging connections for duplex working, and to instruments and codes used in telegraphing. The receiving instrument is connected to the line by means of a "bridge"

arrangement of resistances (and perhaps also with capacities) so adjusted, that it does not signalise except when an electrical impulse is transmitted from the sending station. The new signalling code consists of combinations of dots and dashes and intervals, arranged in two parallel lines, so that between the two marks constituting each signal the intervals of space are obviated Relays with balanced coils, suspended in circular magnetic fields and working tongues between contacts, are described; the relay tongue having a sliding shuttle so arranged as to make contact on either side by a small movement, without limiting the stroke of the tongue. A sending key with a rocking lever, so arranged that successive depressions of the key cause contacts to be made for transmitting currents from separate sources alternately, is also described.

732. "Improvements in electro-magnetic engines."—J. H. LOVEL, dated Feb. 22, 1877. 6d. This consists in forming an armature disc of soft iron on a shaft, and surrounding it with electro-magnets capable of attracting the disc so as to start and maintain the shaft in rapid rotation.

TRAFFIC RECEIPTS.

Name of Co., with amount of capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £90,000.	Cuba Sub. Co. £16,000.	Direct Spanish Co. £13,000.	Direct U.S. Co. £65,000.	Eastern Co. £369,700.	Eastern Ex. Co. £199,750.	Gt. Northern Co. £125,000.	Indo-Euro. Co. £17,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £69,910.	West India Co. £88,320.
	£	£	£	£	£	£	£	£	£	£	£	£	£
January, 1878 ...	49.940	11,877	*3,000	976	13,730	41,531	22,905	13,480	... ...	9,621	1,725	10,419	*5,200
January, 1877 ...	37,780	11,587	2,311	983	13,530	42,580	24,147	12,676	... ...	9,668	2,533	10,342	4,058
†Total Inc. 1878	12,160	290	*689	... ...	200	... ...	... ...	804	... ...	... ...	... ...	77	*1,142
†Total Dec., 1878	... ...	... ...	... ...	7	... ...	1,049	1,242	... ...	... ...	47	808	... ...	... ...

* Estimated. † Compared with same period 1877.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—Since Mr. R. A. Proctor has disowned the authorship of an article on the "New and Wonderful Phonograph" (and even of another effusion on the "Manufacture of Soap") which I in a recent critical note of mine in your columns ascribed to his ubiquitous pen, I now write for the purpose of frankly acknowledging my slight error. The paragraph in question appeared in the "Popular Science" columns of the *Echo*, and that my error in attributing it to Mr. Proctor was really slight and excusable, will appear from the fact, that until quite lately these columns were signed with that gentleman's well-known initials "R. A. P." Though the outer sign was no longer manifest, it was pardonable to suppose that the inspiration of these columns was the same, and I am certain that many readers of the *Echo* will be surprised to learn that the "Popular Science" articles are not Mr. Proctor's. I can assure Mr. Proctor that many of his admirers were of opinion that a recent article on the "Food Value of Soup" was by his hand, and it will, no doubt, be a matter of grievous disappointment to them to hear that it is not.

Mr. Proctor points out that he has not written in the *Nineteenth Century*. I did not expressly say that he did; but at any rate the *Contemporary Review* is the parallel periodical, and if the matter be of so much importance, I willingly correct the former into the atter.

Electricians will be somewhat surprised to hear that the remarkable assertion of Mr. Proctor in the *Gentleman's Magazine* to the effect that ere long we should be able to whisper through the Atlantic cables by means of the telephone was "based on a statement of Sir W. Thomson's." The only statement of the kind I have heard as coming from Sir W. Thomson was a remark that it would soon be possible to talk through "several hundred miles of wire" (meaning land-line, of course). A great deal may be "based" on any statement; and if the great practical distinction between submarine cables and air-lines is not taken into account, it is easy to see how Sir William Thomson's words may mislead.

It will be news to electricians also to learn that Sir William Thomson is not a "professional electrician." I believe I am right in considering that the man who was a chief electrician on board the *Agamenon* during the laying of the early Atlantic cable, and lately acted as engineer for the Western and Brazilian, the Platino-Brazilliero, the West India and Panama, and the Cuba Submarine Company's cables, is a professional electrician as well as a scientific one.

When Mr. Proctor confines himself to matters of astronomy, mathematics, and theology, and deals his vigorous blows at cliquism, or breaks a lance in defence of public right, no one more admires and respects his writings than I do; but when he ventures into the unfamiliar field of telegraphy, he must expect to encounter the criticism of the specialist. Were his authority and ability less, his licence to make bold assertions might with impunity be greater. It is an old, but a wise proverb, which forbids the cobbler to

forsake his last; and although there is a vast difference between enlightenment and leather, I suppose that what applies to the shoemaker applies also to the man of science.

Mr. Proctor speaks of my former remarks as having been conceived in a peevish and petulent spirit. I can assure him that I never enjoyed better humour in my life than while I wrote them.

THE WRITER OF THE "NOTE."

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—Referring to your Editorial of Dec. 15 last, headed "Progress of Electrical Science in England and America," in which you combat the assertion of Mr. Latimer Clark that "English telegraphists are allowing themselves to be beaten by their American rivals, the said assertion having been made in consequence of the great stir and excitement that has been created by the successful working of "The Telephone and Quadruplex Telegraph System," I wish to claim for Canada in particular, and the British people generally, that the telephone was invented by a Canadian, namely, Mr. A. Graham Bell, from Brantford, Ontario, and that the first experimental instrument was made in Canada by a Canadian artisan.

I also wish to claim that Mr. Thomas A. Edison, the inventor of the Quadruplex, Articulating Telephone, Phonograph, Electric Pen, &c., whom you style the distinguished American electrician, is also a Canadian, from St. Thomas, and afterwards Sarnia, Ontario.

These gentlemen gravitated, the one to Boston, and the other first to Boston and then to New York, precisely as on your side of the water those who think they have a mission, or can make their mark, gravitate to London.

I enclose the *Brantford (Ontario) Daily Expositor* of the 19th inst., containing the report of a lecture by Prof. A. Melville Bell (the father of Mr. A. Graham Bell, the inventor), on the Telephone.

The "Tutels Heights" referred to in the lecture is the residence of the lecturer, and I believe the early home of the inventor; it is about three miles distant from Brantford, and is connected with Prof. Bell's town office by a telephonic wire.

I trust you will find room for the lecture in your interesting journal, and thus put on permanent record, in M. A. Melville Bell's own words, that "Canada is the birth-place of the Telephone."

Yours truly,
BEN. B. TOYE.

Toronto, Canada, Jan. 24, 1878.

[We are sorry that want of space prevents us printing in its entirety the report referred to, but the following verbatim extract will be interesting:—"*Canada is the birth-place of the telephone*, and the first experimental instrument was made by a Brantford artisan some five or six years ago. Nearly 4,000 are now in use in the United States, and most of Europe has adopted it in various ways. The first line in Canada was between Rideau Hall and the Premier's office, Ottawa. The Brantford line was the third one erected."—EDIT. TEL. JOUR.]

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—Referring to my letter of the 20th January, I beg to inform you that it has been ascertained that the interruption to the short section of this company's cable between Torbay, Nova Scotia, and Ryebeach, New Hampshire, was caused by its being hooked and broken by the anchor of the schooner *William H. Raymond*, Captain Swim, belonging to the port of Gloucester, Massachusetts.

The captain of the schooner furnished this information.

I am, Sir,
Your obedient Servant,
CHARLES CLARKE,
Secretary.

The Direct United States Cable Company, Limited, London, E.C.
9th February, 1878.

To the Editor of THE TELEGRAPHIC JOURNAL.

Sir,—In your issue of 1st February, we notice a letter from Mr. W. B. Woodbury in which our names are mentioned. This gentleman must excuse us if, while disclaiming for ourselves any part in the invention of the *modus operandi* referred to, we yet fail to recognise the validity of the claim he has made on his own behalf to it. It will, we think, be sufficient to refer him to the *British Journal of Photography*, 5th May, 1876, where in a special article by the Editor, it is accredited to Mr. Paul. If Mr. Woodbury can refer us to any Journal wherein he published it prior to this date, his claim will be indisputable; if not, we hope he will (on the principle of the 11th commandment), drop a claim he cannot substantiate, and give the credit to the proper party. We send you herewith copies of the *British Journal of Photography*, 5th May, 1876, and 18th August, 1876, and if you will compare the leading article to the former with an extract from a publication of Mr. Woodbury's in the latter, you will see at once the two methods are identical in principle and practice, in fact they are *one* and the same.

Yours obediently,
WRATTEN & WAINWRIGHT.

London, W.C., February 10th, 1878.

TRINIDAD.—The price of a set of telephones is £25. Each set consists of a pair of telephones and a call bell on a stand—the equipment for one end of a line. The senders and receivers cannot, we believe, be purchased separately. The apparatus can be worked on an ordinary suspended wire, provided other working wires do not run on the same poles with it; if they do, it is difficult to hear distinctly, while the wires are working, from a peculiar crackling noise which is heard, and which is due to induction from wire to wire. Full particulars as to terms, &c., can be obtained from the agent, COL. REYNOLDS, 115, Cannon Street, E.C.

Proceedings of Societies.

PHYSICAL SOCIETY.—2ND FEBRUARY, 1878.

ANNUAL GENERAL MEETING.

The President, Professor G. C. FOSTER, in the Chair.

The President read the Report of the Council for the past year. After pointing with satisfaction to the present condition of the society, the report goes on to show how it is hoped to extend its usefulness in the future. In addition to a second edition of Professor Everetts' work on the C.G.S. System of Units, the Council hopes very shortly to publish Sir Charles Wheatstone's papers in a collected form, and it is making arrangements for the publication, at intervals, of translations of foreign scientific papers, especially such as have had a marked effect on the progress of physical science. A portion of

the funds of the society is to be devoted annually to the formation of a library, and an exchange of publications is already made with various learned societies abroad. Special stress was laid on the distinctive object held in view at the formation of the society, namely, the exhibition, when practicable, of the experiments referred to in papers read at the meetings.

The following officers and council were elected for the ensuing year:—*President*, Professor W. G. Adams, M.A., F.R.S.; *Vice-Presidents* (who have filled the office of President), Dr. J. H. Gladstone, F.R.S., and Professor G. C. Foster, F.R.S.; *Vice-Presidents*, Professor R. B. Clifton, M.A., F.R.S., W. Spottiswoode, LL.D., F.R.S., W. H. Stone, M.B., F.R.C.P., Sir W. Thomson, LL.D., F.R.S.; *Secretaries*, Professor A. W. Reinold, M.A., W. Chandler Roberts, F.R.S.; *Treasurer*, Dr. E. Atkinson; *Demonstrator*, Professor F. Guthrie, Ph.D., F.R.S.; *Other Members of Council*, Capt. W. de W. Abney, R.E., F.R.S.; Professor W. F. Barrett, F.R.S.E.; Major E. R. Festing, R.E.; W. Huggins, D.C.L., F.R.S.; Professor A. B. W. Kennedy, C.E., O. J. Lodge, D. Sc., Professor H. M. McLeod, the Earl of Rosse, D.C.L., F.R.S., Professor W. C. Unwin, B. Sc., R. Wormell, D. Sc.

Professor H. L. F. Helmholtz and Professor W. E. Weber were elected honorary members of the society.

After votes of thanks had been passed to the Lords of the Committee of Council on Education for the use of the Physical Lecture Room at South Kensington, as well as for the other advantages enjoyed by the society, and to the several officers of the society, the meeting was resolved into an ordinary one.

The following candidates were elected members of the society:—M. S. Cormack, C. J. Faulkner, M.A., E. M. Jones, F.R.S., C. Leudesdorf, M.A., and C. E. Walduck.

Professor S. P. THOMPSON exhibited a method of showing the lines of force due to two currents of electricity running in parallel directions. A plate of glass is perforated by two holes close together, which are traversed by one and the same wire, and this may be so arranged that the current traverses the parallel lengths in the same or opposite directions. If now the plate be held horizontally while the current passes, and fine iron filings be sprinkled on the plate, they will arrange themselves in the well-known forms. In the plates exhibited, the filings had been fixed by gum, so that their arrangement could be exhibited to an audience by projection on a screen.

General Science Columns.

MINUTES OF PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS, SESSION 1876-77. PART II.—The first paper in this volume on "The Repairs and Renewals of Locomotives," by Mr. McDonnell, deals principally with statistics compiled from the author's own experience on the Great Southern and Western Railway of Ireland, though it also contains sound, valuable tables on the same subject obtained from the principal railways in England, and some foreign railways. Such papers are useful for reference, and of special value to locomotive superintendents, as showing the comparative outlay on the various lines, and in what respects economy might be practised.

It is, however, very difficult to institute a perfect comparison between any two railways, as the gradients, the mode of working, and the method of keeping records and accounts differ considerably. Thus in the discussion on the paper, the late Mr. J. Armstrong, for several years locomotive superintendent of the Great Western Railway, showed that in consequence of so much of the work being done at the railway's workshops at Swindon, many items appeared under the head of wages in the Great Western returns which appeared under the head of materials in the tables furnished by the author. Mr. Armstrong also showed that the worst gradients on the Great Western were considerably steeper than those on the Great Southern and Western, rendering a comparison unfavourable to the former railway. The cost of renewals and repairs of engines on five of the principal railways in England and the Irish railway referred to was between 2½d. and 3½d. per train mile.

The second paper treats of the "Utilisation of Refuse Vegetable Substances as Fuel for Agricultural Steam Engines." In England coal is cheaper than any other fuel, and straw, if employed as fuel, would cost about five times as much as coal; but in many countries, where coal is not found and carriage is difficult, the state of the case is exactly reversed. In Russia, Hungary, India, South America, and other countries the cost of coal as fuel is about three and a half times as much as straw. The objections to the use of vegetable refuse as fuel are, the necessity of constant feeding of the fire owing to the bulkiness of the fuel and the rapidity of consumption, the tendency to check the combustion by the introduction of damp fuel, and the deposition of silica on the bars of the grate. These difficulties have been surmounted in the machines described in the paper, by providing an automatic feeding apparatus which inserts the fuel in a fan shape into the furnace, pushing forward the fuel in front gradually into the middle and further end of the furnace where the combustion is most active, and the deposits of silica is constantly removed by a rake working along the bars before it has had time to harden. These machines are specially suitable for burning straw, reeds, brushwood, cotton stalks, and the refuse of sugar cane.

The third paper in the volume is "On the Sewage Question," a subject which, in one form or other, is from time to time brought forward at the meetings of the Institution, and invariably produces an animated discussion, as the parties of the various systems in use, or proposed for the disposal of sewage, are eager to promulgate their views. The paper before us discusses freely the merits of the principal systems which are classified as follows. (1) Treatment with chemicals. (2) Application of sewage to land, including irrigation and intermittent downward filtration. (3) The dry earth system. (4) The Liernur or pneumatic system. (5) Seaward and tidal outfalls. The first is condemned as costly and impracticable, except as subsidiary to investigation; the second is approved of where land can be readily procured; the third is considered inapplicable for dealing

with the sewage of towns; the fourth is condemned; but unqualified approval is given to the fifth, as applicable to all towns within the tidal range of rivers or on the sea coasts. This last system, Mr. Norman Bazalgette treats as a self-evident proposition; he asserts in opposition to the evidence given by impartial observers, that no silting-up has occurred in the Thames near the Metropolitan outfalls, and considers it a logical inference, that in the absence of disturbing causes, no deposit can take place where the velocity of the current into which the sewage is discharged is greater than the velocity of flow in the sewers; and as might be expected from a barrister pleading a cause, he omits entirely from his arguments the effects of slack-water in a tidal river, and forgets that there is a flood as well as an ebb-tide, which will bring back the sewage taken down by the ebb. The long discussion which followed can have hardly realised the hope expressed in the paper, that a more unanimous opinion on the subject might be promoted by the conclusions with which the paper terminates.

The proper disposal of sewage is a very difficult problem, but we do not despair of some solution being eventually found. Sewage has an agricultural value, but except by irrigation, no perfectly satisfactory method has as yet been discovered of applying it to the land. Many chemical processes have been tried with only partial success. The earth closet system is only applicable to small towns on account of the cost of carriage. Land for sewage farms is expensive in the neighbourhood of towns, and the limited area of land on which the sewage is deposited, causes the amount used to exceed what is desirable. Outfalls into tidal rivers are objectionable, especially where the river near or below the outfall has towns or villages on its banks; as the sewage travels very slowly to the sea, the river is always largely contaminated with it, and even if no palpable deposit occurs, the bed of the river becomes gradually impregnated with sewage. It does not seem probable that a process will be discovered for rendering sewage a valuable product commercially; but we trust it is not beyond the resources of science to devise some means by which our tidal rivers may be freed from pollution, and sewage applied to land at a less cost than that required for throwing it into the sea.

Two short papers on Canadian narrow-gauge railways, and on the emission of heat by hot-water pipes, are printed in the volume, which also contains, as usual, several abstracts of articles from foreign periodicals.

TRANSACTIONS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, November, 1877.—There is an article on the "Nomenclature of Building Stones and of Stone Masonry," in this number of the Transactions, written with the object of obtaining a more uniform nomenclature for dressed stone and masonry; and to render the subject more complete, a description is also given of the various tools used by the stonemason. The article is fully illustrated by plates, showing both the tools employed and the various dressings of stone, and the different classes of masonry. The rest of the pamphlet is filled with an account of the proceedings at the annual meeting of the society.

INDIAN IRRIGATION WORKS.—A great deal of misunderstanding at present exists, even amongst the otherwise well informed, in this country, regarding the remunerative character of irrigation works in India. Sir Arthur Cotton admits himself to be a man with one idea, but really he has two ideas; one, that irrigation works in India are immensely profitable and ought to be enormously extended; and the other that India ought to and could, be traversed in its length and breadth by lines of water communication; irrigation channels being also made adapted for purposes of navigation. In his views generally, Sir Arthur Cotton has some few supporters who ought to know something of the subject, and doubtless a great many more who accept his statements and figures, but who, of themselves, know nothing about it. About three years ago a book was published, by an anonymous author, entitled "The Indian Problem Solved—Undeveloped wealth in India and State reproductive works. The ways to prevent Famines, and advance the material progress of India." This publication consists of a compilation of extracts from reports, letters, and official documents, bearing generally on the subject of irrigation works, apparently carefully selected with the view of advancing what is in some quarters known as the Cottonian theory; which theory, we are prepared to show, is capable of having a very different light thrown upon it when viewed from the other side of the question. It matters little how many supporters of his views Sir Arthur Cotton may find, or how many books are published for the purpose of expounding his theories; but when the subject is publicly taken up by a person of Mr. John Bright's position, and Sir Arthur Cotton's figures and estimates are accepted by him in their entirety, it is quite time that the question should be publicly taken up and discussed with the view of ascertaining how far the strictures passed on the Indian Government by Mr. Bright are justified by facts, or whether Sir Arthur Cotton is not a little too sanguine in his views.

The one work instanced as a proof of the extremely remunerative character of irrigation in India is the Cauvery delta system of canals, which has yielded a return of over 85 per cent., upon a capital outlay of a little over £133,000. This, it must be admitted, is but a small expenditure from which to estimate the probable returns from a further proposed outlay of between 25 and 30 millions on similar works. Besides this, a little further examination into the circumstances of this exceptionally remunerative work, may perhaps tend to throw such a light on the subject as to alter the whole question. In the first report of the Madras Public Works Commissioners, there is given an extract from a report, dated August 12, 1844, by Sir (then

Captain) A. T. Cotton, wherein it is stated, with regard to the district of Tanjore, "When we got possession of that district it was in a far more advanced state than Rajahmundry is now; there was already something like a system of irrigation, and especially one main work, the grand anicut, built to prevent the Cauvery rejoining the Colleroon; so that the district, or at least those parts of it that were irrigated, were not dependent merely upon the high freshes of the river, but received a supply of water almost as long as there was any in the Cauvery." This ancient native work was a solid mass of rough stone 1080 feet long and 40 feet broad, stretching across the bed of the Cauvery, and is supposed to have been built upwards of 1600 years ago, according to the "Moral and Material Progress Report" on India for the year 1871-72, page 58. Captain Cotton's Report goes on to say, "soon after the assumption of the country, the grand anicut was raised; by degrees innumerable small works, such as sluices, &c., and new channels, were executed; the river banks were extended and strengthened; and at last two new anicuts were constructed on the Colleroon to prevent the escape of any water to the sea." In 1836, before the construction of any of these additional works by the British, the Cauvery and Colleroon supplied irrigation to 630,613 acres; in 1850, it was 716,524 acres, and now it is over 800,000 acres, or about half as much again as it was before any of the above mentioned sum of £133,000 was laid out upon the works. In order then to ascertain what return is actually obtained from that expenditure, it will be necessary to examine the matter a little more in detail. In the Godavery delta, irrigation existed before the present works were constructed, but no anicut had been built as in the case of the Cauvery. The cost of the present irrigation works in that delta has amounted to about Rs. 13 per acre irrigated. In the Kistua delta, irrigation channels were also in existence before the construction of the existing works, and they have cost Rs. 19 per acre, whilst we are asked to believe that the Cauvery works have cost only Rs. 1¼ per acre of land irrigated. If, allowing for the ancient native works on the Cauvery, the cost of the works as they now stand be taken at Rs. 15 per acre irrigated, the capital expenditure will amount to Rs. 1,25,28,120, or between nine and ten times the amount with which they are credited, a sum far more likely to represent the true value of the works than the bare amount spent on them by the British Government, and the per centage of net revenue will then be reduced from 85 to about 9½ per cent., a result in itself satisfactory, and probably not far from the real truth. We must defer a consideration of the other issues raised by Sir Arthur Cotton for a future occasion.

DETECTION OF TRACES OF COPPER.—M. L. Cresti (*Gassetta Chimica Italiana* vii., 220-222). On immersing a small couple formed of zinc and platinum wires in a solution containing even a mere trace of copper, the copper is deposited on the platinum wire, and if it be exposed to the vapour of hydrobromic acid, it is converted into copper bromide. If, however, the platinum wire coated with copper be exposed while still moist to the vapour of bromine and then to the vapour of hydrobromic acid, or *vice versâ*, an intense violet coloration, even with a very minute quantity of copper, is produced. The best plan is to expose the moist coating of copper to the mixed vapours of bromine and hydrobromic acid given off in treating potassium bromide with concentrated sulphuric acid. The tint may be seen with advantage by touching a white porcelain plate with the point of the moist platinum wire after exposure; after the experiment, the wire may be inserted into the flame of a Bunsen burner to show the green copper flame. M. Cresti considers the blue coloration to be due to a combination of hydrated copper bromide with hydrobromic acid.

ESTIMATION OF ZINC AND LEAD IN MINERALS BY ELECTROLYSIS.—MM. G. Parodi and A. Mascazzini (*Gassetta Chimica Italiana* vii., 222-224) find that zinc can be precipitated on platinum in a coherent film, which can be washed and weighed, if the solution be first rendered ammoniacal and then acidulated with an organic acid, preferably acetic, and submitted to electrolysis, care being taken to adjust the current to the strength of the solution. The iron, lead, &c., present in calamine, blende, and other zinc minerals, should be removed by Schwartz's method before electrolysis. The presence of a trace of lead increases the coherence of the film, if no mineral acid but sulphuric be present. Lead may be precipated in a coherent state by acting on alkaline solutions containing phosphoric and tartaric acids. The presence of acetic acid tends to keep the positive pole free from lead peroxide.

THE FOSSIL BEDS OF OREGON.—These remarkable fossil deposits are situated near Fossil Lake, twenty-six miles north-east of Silver Lake, in Lake County, Oregon. They might have remained for a long time undiscovered but for the action of the wind which has laid them bare. There appears to be a constant wind from the south-west in that district, which has scooped out the surface sand and piled it up at a distance in mounds of every conceivable form and beautifully stratified. In the bottom of the hollow thus excavated have been found fossil bones of the elephant, camel, horse, elk or reindeer, those of the horse being by far the most abundant. Bones of smaller quadrupeds were also found: for example, the fox, wolf, and goat. Many remains of birds, waders, swimmers, scratchers, and probably climbers, were recognised, as also the vertebræ of fishes. The fossils thus revealed lie scattered on the ground in a north-east and south-west direction, over an area four or five miles long by a mile wide. Near the south-west end of the deposit are two small lakes or ponds, highly impregnated with alkali. Further exploration of this interesting locality may bring to light

many vestiges of past life of great importance to the paleontologist.

COLDNESS OF LEAVES.—In a recent memoir to the Academy of Sciences, Paris, on the functions of leaves, M. Joseph Boussingault attributes the fresh feeling of living leaves even in the sunshine to the evaporation of the sap of the plant from their surface. When a leaf is detached from its parent stem the sap is cut off, and the feel of the leaf is the opposite of fresh.

SOLAR PHOTOGRAPHS. — Solar photographs are a valuable supplement to telescopic observations, and since they admit of direct comparison from time to time, it is possible by means of them to discover varying phenomena which the telescope alone might never reveal. It has been recently found by M. Janssen, from photographs taken at the observatory of Mendon, that the granulations on the solar disc, known as "rice grains," have a very variable luminosity depending on their depth within the gaseous masses which surround them.

"LOUPES."—This article of trade is much sought after in the mountains separating the Caspian provinces from Irak, or Persia proper. As is well known, *loupe* is the French term for the great burrs, wens, or excrescences on trees, from which the handsome veneers are cut for inlaying fancy furniture. Walnut, maple, wainscot oak, and other cabinet wood yield these finely marked curled excrescences. It is only produced in the highlands, where it may be purchased at a very low rate; but, owing to the labour attending its transport in a country destitute of means of communication, it costs too much for speculative purposes to bring it down to the ports of shipment. Some good specimens of this valuable excrescence were, notwithstanding, brought down last season. The best marked samples of this wood are sent to England, *via* Tiflis, while the ordinary qualities suit best the French market. Some loupes are to be found weighing upwards of a ton; but, owing to the means of transport, they have to be reduced in size. . . The loupe is introduced into a large receptacle, and steamed for several days consecutively, until, from the adamantine hardness it naturally possesses, it assumes the consistency of cheese. It is then placed under a machine, which, with a large blade, slices it off into sheets, which harden by exposure, and are sold in the market according to size and beauty of design; some loupes, in Paris, have fetched as much as £800 sterling.—*Consul Churchill's Report.*

GEOLOGICAL TIME.—At a recent meeting of the Royal Society, the Rev. Samuel Haughton read a paper on the limits of geological time. Mr. Haughton has already given good reasons for his opinion that the elevation of the continents of Asia and Europe displaced the axis of *maximum inertia* one degree from its former position. The axis of rotation of the earth, thus displaced through sixty-nine miles from the axis of the figure, began to revolve round it. But for the friction of the ocean on its bed this displacement of the axis of rotation from the axis of figure would continue for ever. The ocean, however, tends to keep revolving round the axis of yesterday while the solid earth is of course revolving round the axis of to-day. In this way friction of the ocean on its bed takes place, the ocean acting as a liquid friction brake, and this tends to bring the axis of rotation back to coincidence with the axis of figure. Mr. Haughton's calculation brings out the result that 641,000 years would be required to restore the coincidence of the axis, and, therefore, the formation of the continents of Asia and Europe cannot be more recent. Further calculations assigned the lower limit of geological time as eleven million years in round numbers.

NATURE'S HYGIENE.—There is good reason for believing that the presence of trees in certain miasmatic localities have the effect of rendering the air healthful. It is not yet a settled point whether the beneficial influence is confined to certain trees or is common to all, and whether it is an effect of certain secretions of the tree, or due merely to its screening action on the malaria. In support of the latter view two cases from India have been cited, namely one in which a station which was screened from a large swamp by a grove of mango trees, becoming very unhealthy when the trees were cut down, and recovered its healthiness on their being replanted; and one in which an unhealthy station, near a marsh, became healthy when a forest of babool trees were intervened between it and the swamp. The Trappist Monastery at Tre Fontane, near Rome, was until recently so fatal that one by one the monks sent to it succumbed to fever. With praiseworthy perseverance the monks have planted a vineyard, and many eucalyptus trees round it, and now the place is much healthier, and the monks attribute the change to the eucalyptus. It is generally believed that the atmosphere of pine forests is favourable to invalids suffering from pulmonary disease, and it has been supposed that the oxydation of the oil of turpentine exuded from pine trees, and of other essential oils such as the odorous oils of flowers in the air is attended by the formation of ozone, because the oxydized oils and the air in their vicinity exhibit the reaction of ozone with potassium iodide and starch. It has been well proved that the air of the country contains an oxydising and odorous substance called ozone, capable of bluing iodized red litmus paper, of decolorising blue litmus paper without previously turning it red, and of destroying bad smells. It is supposed by some that ozone is in great abundance in eucalyptus forests, and hence the reputed sanitary effect these trees have; others attribute their power to the rapid absorption of the marsh waters. Recent experiments of Mr. Thomas Taylor on the preservative

properties of eucalypti demonstrate the fact that oxydation of the gases of malarial districts, and consequently their improved health conditions in the presence of the essential oils of the eucalyptus family, or of other odoriferous plants, are not necessarily the result of ozone. Any acid or substance having an acid reaction will oxydise the potassium of iodide of potassium (the usual test for ozone); eucalyptol, turpentine, benzol, or any of the essential oils will oxydise potassium when it is combined with sulphur or iodine, hence the purification of the atmosphere may be to some extent effected without having recourse to the theory of ozone. Mr. Taylor also finds that skins of animals may be preserved by rubbing the fleshy side with eucalyptus oil. If combined with plaster and injected into the veins and arteries of animals it will preserve the flesh from decay. Beef or other animal matter can be preserved in a fresh state by it. The result of his experiments are that nearly all essential oils, and especially eucalyptus oil and turpentine, possess an oxydising property, with the power to decompose certain products deleterious to health, which are always present in malarial regions, and result from animal and vegetable decay.

MANGANESE BRONZE.—This new alloy, which is composed of fifteen parts copper, four parts magnanese, and one part zinc, exceeds in tensile strength both Muntz metal and gun-metal. At the Woolwich Arsenal recently a cold rolled bar one square inch in sectional area, sustained a load of forty tons before breaking. The weakest kind is half as strong again as Muntz metal, and at the same time sufficiently ductile to be rivetted cold. It can be converted into thin sheets, plates, tubes and wires, and is much superior to brass for such a purpose, being twice as hard and twice as strong. It is particularly well suited for boiler and condenser tubes of engines, since the highest temperature it can be subjected to in a locomotive or other high pressure engine does not appear to reduce its hardness, toughness, and rigidity in the least.

PHOSPHOR BRONZE.—It has until lately been believed that tools of copper or gun-metal were incapable of giving out sparks of fire in working, and it has been hitherto the custom to use them in connection with explosive materials; but it has been recently proved that friction produces sparks from both of these metals, and it has therefore been ordered that in future all implements employed in the manufacture and manipulation of gunpowder for the Government shall be made of phosphor-bronze, which is the least liable to strike fire of all known metals suitable for the purpose.

EFFECT OF GAS LIGHTING ON LEATHER.—Professor A. H. Church points out that the well-known disintegrating effect of the products of gaslight in rooms on the leather binding of books, is probably due in the main to sulphur. It appears that vellum is not affected by the fumes, morocco very slightly, calf considerably, and Russia most of all. The injurious effect is always most marked on the upper shelves of a library, whither the heated products of combustion ascend, and are absorbed by the leather. In newly bound books, the quantity of sulphur in the leather is found to be small, and due to traces of sulphates in the size and dye; there is no free sulphuric acid to be found. But in the case of old library books, in which the leather has become dry and friable, as much as eight per cent. of sulphuric acid has been found, six per cent. being in a free state.

FOREST TREES OF CHILI.—Some time ago it was stated by the Liverpool Chamber of Commerce that the supply of material for tanning leather was falling off in England. Mr. T. Plelsey, a Peruvian gentleman, therefore draws attention to *luigue*, a tree of Chili, a species of oak whose bark is used for tanning leather. It is found in the extensive forests of the province of Baldivia, where there are other large and handsome trees, such as the *loroutilla* and the *ulma*, which, like the *auracaria* or Chili pine, would be a beautifying acquisition to English parks and gardens.

THE COQUITO PALM.—In Chili a sweet syrup, called *miel de palm*, or palm honey, is prepared by boiling the sap of the *jubœa spectabilis* to the consistence of treacle, and it forms a considerable article of trade, being much esteemed for domestic use as sugar. The sap is obtained by the very wasteful method of felling the trees, and cutting off the crown of leaves, when it immediately begins to flow, and continues to do so for several months until the tree is exhausted, provided that a thin slice is shaved off the top every morning. Each tree yields about 90 gallons of juice. The small nuts, which resemble miniature cocoanuts, are used by the Chilian confectioners in the preparation of sweetmeats, and by boys as marbles.—*Journal* (*American*) *of Applied Science*.

FOSSIL FERNS IN SILURIAN ROCKS.—It has hitherto been considered by geologists, that the Silurian rocks of Europe contain no remains of plant life except *algœ*, but fossil ferns have recently been discovered by M. G. de Saporta, in the Silurian system of Angers, in France. The specimen was found in a slab of schistose rock from the Middle Silurian strata, and though somewhat imperfect, was tolerably well preserved. The vegetable matter had been replaced by iron pyrites. The veining of the frond shows that the ferns resemble some of those peculiar to the Upper Devonian and Lower Carboniferous period. Although this is the first evidence of so high an order of vegetable life in the European Silurians, fern remains have before been discovered in some of the American Silurians. As ferns are highly organised plants, it is probable that others less complex in structure may yet be found in those rocks.

METEORITES.—It is estimated by Professor Newcome of America, that four hundred million shooting stars are fused daily in the earth's atmosphere. The resulting *débris* slowly settles to the ground, and must produce an increase of the earth's mass. According to Professor Harkness, of the American Naval Observatory, the average weight of each meteorite does not exceed a grain. Those visible only by means of the telescope are probably no larger than sand grains, and those which are seen over a radius of 150 miles, and fill several cubic miles of air with the smoke of their dissolution, are probably several ounces, perhaps pounds, in weight. Taking each meteor to weigh ten grains instead of one, the four hundred millions which reach the earth daily would amount to 290 tons of matter added each day to the earth's mass, or 106,000 tons yearly. This quantity, if distributed equally over the earth's surface, would form in four million years a stratum about the thickness of ordinary paper.

METEORIC IRON.—Some large polished plates of meteoric iron sawn out of the metoric masses which have been found in the province of Santa Catharina, Brazil, were recently on view at the Academy of Sciences, Paris, and presented a remarkable mosaic structure made up of angular fragments of metallic iron, bound together by a cement composed of pyrhotène, graphite, and magnetic oxide of iron. M. Daubrée has reproduced the cement by heating an iron wire to redness and exposing it to the action of the vapour of sulphuret of carbon.

ELECTROSTRICTION. — Professor Young has found that when a thermometer bulb is coated with silver by chemical means, and then electrotyped over with the same metal, the mercury rises in the tube to a definite position on the scale independently of temperature. Copper, silver, iron, and nickel in this way "constrict" the bulb, whereas zinc and cadmium distend it.

KNOWN PLANTS.—The total number of known species of plants at the present time has been estimated at 90,000 dicotyledons, 20,000 monocotyledons, and 40,000 cryptogams,—about 150,000 species divided into 8,000 genera. It is highly probable that this number will, at least, have been doubled, when the whole surface of the earth has been explored.

NEW MATERIAL FOR PAPER.—For many years a cheap substitute for rags in the manufacture of paper has been diligently sought. Straw, rushes, esparto grass, woody fibre, &c., have been tried in town, but it has been necessary to supplement them by an admixture of rag, in order to produce the finer qualities of paper. A new and likelier material is said to have been discovered in the pith of the *Yucca Draconis*, a giant cactus of the Mohave Desert in Arizona, where it flourishes in thick brakes, resembling forests.

USES OF CROOKE'S RADIOMETER.—As velocity of its rotation depends upon the intensity of the light, it is a reliable instrument to measure the value of illuminating gas, and compare it with any adopted standard. When, for instance, it has been found that a certain instrument makes twenty revolutions per minute when exposed to the light of a standard candle, at the distance of say six inches, a gas flame which excites twice or four times this velocity, will be a two or four candle light; or it may be placed at such a distance as to sustain the same velocity of rotation, when the squares of the comparative distances will give the comparative intensities.

The instrument demonstrates directly the law that the intensity of light decreases as the inverse ratio of the squares of the distances. For instance, if a candle placed at a distance of six inches causes forty revolutions per minute, at three inches, or half the distance it will give 4 × 30 or 120 revolutions; at twelve inches or double the distance it will give ¼ × 40 or ten revolutions per minute, and so on. It may, therefore, be used before a class of physics, to demonstrate an important law in optics of extensive application in astronomy, as well as in the art of determining the value of various kinds of artificial flames used for illumination.

The instrument may be used by photographers. Placing it near the sitter, the operator may observe how many revolutions it takes to make a good picture; and then he may for the future count, not the number of seconds, making it more or less in proportion as he guesses the light to be stronger or weaker than usual, but simply count the number of revolutions of the instrument. If once, say with twenty revolutions per minute, he made a good picture, he may be pretty certain that, if the light is only half as strong and requires double the time of sitting, the instrument will occupy twice as much time to make the twenty revolutions; and, when, inversely the light is say one-fourth stronger requiring one-fourth less time of sitting, the instrument will go just so much faster, and make the twenty revolutions in exactly so much less time.—*Manufacturer and Builder.*

City Notes.

Old Broad Street, Feb. 14, 1878.

THE meeting of the proprietors of the Anglo-American Telegraph Company appears to have been free from unpleasantness. Viscount Monck, who was in the chair, made a statement, and moved the reception and adoption of the report. The report was adopted and received by a unanimous vote, and the proceedings terminated in the usual manner. We have already announced that the dividend declared was 1½ per cent., making 4 per cent. for the year. The total receipts of the company from July 1 to December 31, including a

balance of £1,506 carried over from the last account, amounted to £283,319, while the total expenditure of the half-year, including income tax and the ordinary repair of cables, was £42,591. But there is a huge item, not charged to the half-year's expenditure, of £86,960 for a "special repairing expedition." This amount is debited to the renewal fund, a course which, at any rate, invites criticism. The directors have shown some courage in resolving to increase by £50,000 the sum laid by every year until, as the chairman appropriately observed, the reserve fund is more secure. But it appears to us that though this is a move in the right direction, it is not enough. A company with a capital of seven millions ought to have a very large reserve fund; that of the Anglo Company is, at present, altogether inadequate. In a single year nearly £100,000 of it had been swept away, and who can venture to assert that a corresponding sum may not be needed any other year? If the directors are wise they will next half-year propose that £250,000 per year be put aside towards reserve. Let a good dividend be paid, by all means, if possible, but not at the risk of reducing the reserve fund. When will directors see that no company can be really strong which does not, happen what may, keep up an adequate reserve? Perhaps the directors think that as the company has practically only three cables the addition to the reserve is sufficient.

There is one point in the speech of the chairman of the Anglo-American Company which we note with special pleasure, because it shows that the *Telegraphic Journal* has not advocated the claims of engineers in vain. Lord Monck, referring to the working expenses of the company, confessed that they had been reduced to the lowest point compatible with efficiency, and the shareholders might have rather to look to some increase of expense in connection with the salaries of their officers. We have always sought to protect—and shall always seek to protect—the interests of the public and the interests of the shareholders as against the interests of company promoters and speculators. But we shall also never cease to assert that the interests of the public and of the shareholders are best maintained by the employment of well-paid and, therefore, probably able officers. The directors of the Anglo Company, and the observation applies to other companies, will do well to increase the salaries of their officials without delay. It is certain that the companies which are liberal in their treatment to their employés, will continue to command the services of the most capable men—and capable officials help to make, as incapable ones may help to mar, the fortunes of a company.

Does not the *Daily Telegraph* know the difference between the Submarine Telegraph Company and the Cuba Telegraph Company? Yet we learn from our contemporary that the directors of the Submarine Company have declared a dividend of 8 per cent. on the ordinary shares, that they have carried forward a sum of £227 16s. 6d., that they have placed £2,500 to the reserve fund—in fact, the figures are identical with the figures in the report of the Cuba Company. If the City editor of the *Daily Telegraph* will refer to the report of the Submarine Company he will learn that that company will pay a dividend of 17 per cent. per annum, and that the receipts for the half-year show a decrease of £2,465 compared with the corresponding period last year.

The directors of the Submarine Telegraph Company do not seem to think that they have any reason to grumble at the decrease in their receipts; in fact "considering the political state of Europe, and the extraordinary depression in trade," it appears to them to be "a matter of congratulation" that the company has not done worse. We cannot quite agree with the directors of the Submarine Company; we should have thought that very fact of the excitement in Europe would have been the means of increasing the revenue of the company. It has been so in other cases. The dividend is, of course, a good one. We shall note the proceedings at the meeting—which is being held as we go to press—with interest. The cost of renewing the land line erected in 1859 between Cape Grisnez and Boulogne, in connection with the Boulogne Cable, has very properly been charged against the revenue of the half-year.

The directors of the Cuba Submarine Telegraph Company have declared a dividend of 8 per cent., leaving £228 to be carried forward. We learn from the report that the gross receipts for the half-year, including the the balance brought from last account, amount to £16,466 9s. 8d., and the expenses to £4,338 13s. 2d., which is highly satisfactory. But the directors of the Cuba Company have made one little mistake: the amount they have placed to the credit of the reserve fund is too small. It would have been far better policy to have added to the £2,500, and been content to pay a smaller dividend. There really seems to be something like a mania for neglecting Reserve Funds. The smaller companies have caught the malady from the large ones. It is to be hoped that both large companies and small ones will soon see the folly of a policy which is incapable of justification. A hundred pounds seems a large sum for a company like the "Cuba" to spend in six months on "law charges." But we presume the charges were involved in the proceedings instituted by the company against the Spanish Government in the matter of the tax levied on their local business in Madrid. We cordially hope that the decision will be favourable to the company.

Those who predict that another year will witness an extension of telegraph business must bear in mind that the traffic returns of most of the telegraph companies have been exceptionally high the last twelve months. No doubt if the Eastern Question is not disposed of shortly—above all, if there be a development of the war, the returns will not diminish in 1878; but the moment there is peace, telegraphic messages will decrease in numbers and in length. Of course it may be urged that the traffic receipts of the Anglo-American and Direct Companies were below the mark last year; and that, we admit, was so. But all things considered, 1877 may be said to have been a prosperous year for the principal telegraphic companies.

It is announced that the Telegraph Construction and Maintenance Company will, subject to the audit of accounts, pay a dividend of 15 per cent. (£1 16s. per share) in addition to the *ad interim* dividend of 5 per cent. already paid, making 20 per cent. for the past year. That this company—which, by the way, is said to have executed contracts to the total amount of one million sterling during 1877—is admirably managed, must, at least, be granted.

The half-yearly report of the Metropolitan District Railway Company is encouraging. In 1872 the company did not pay any dividend; in 1873 only half per cent.; 1874 one and a half; 1875 two and three quarters; and in 1876 three and a half per cent. But in 1877 the company made sufficient progress to enable the directors to pay four and three quarters per cent. It is very satisfactory to learn from the report, and also at the meeting of shareholders, that the Metropolitan Company have distinctly recognised the principle that the completion of the Inner Circle scheme should be effected at the joint cost of the two companies, because it thus becomes a matter of more than surmise that the Inner Circle will really be completed some day. We shall be glad to see the Circle commenced.

THE TELEGRAPHIC JOURNAL.
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TELEGRAPHIC COMMUNICATION WITH THE CAPE AND BERMUDA.

IN view of the critical state of European politics at the present time, the possibility of our entering upon a war, and the importance of maintaining our telegraphic communications with our Eastern possessions intact, Mr. Donald Currie, the extensive shipowner, has again drawn public attention to the question of connecting the Cape Colonies and also Bermuda by cable to England. Mr. Currie states his views in a letter to the *Times* of February 12th. Being of opinion that the Indo-European lines, running as they do through Russia, Turkey, and Persia, and also the Mediterranean cables, could be without difficulty interrupted by a hostile power, he advocates the advantages of an alternate route to India *viâ* the Cape. Such a route would be of great value in an Eastern or a Caffir war, and provided we could telegraph to the Gold Coast, St. Helena, and Simon's Bay, it would be of great service in controlling fleets. The subject was brought by Mr. Currie before Lord Carnarvon in 1875, and has recently been brought before Sir Michael E. Hicks-Beach, Lord Carnarvon's successor in office.

There is little doubt but that the Cape Colonies would willingly assist the Government in defraying the expenses of a West Coast of Africa cable from England to the Cape; but even then the cost would be likely to deter our Government from undertaking the work. Mr. Currie therefore proposes to connect the island of St. Vincent, in the Cape de Verds, with Goree, a West Coast settlement, at which the mail steamers bound for the Cape could call instead of at Madeira, and by this plan the Cape would be brought within eleven or twelve days of England. An extension of telegraphic communication to the whole of the British West African settlements would, he thinks, be of immense value to the nation, both navally and commercially, and he regards an African East Coast line between the Cape, Mauritius, and Aden, as an imperial necessity. Mr. Currie also draws attention to the fact that we have no cable communication with Bermuda, the winter headquarters of our North American and West Indian squadrons, and the only place at which we have a floating dock. At present our only means of corresponding with Bermuda is by the fortnightly steamer from New York, or the monthly one from Halifax. Cables from England to Bermuda, and from Bermuda to Jamaica, in conjunction with the African coast cables proposed, would bind all our naval stations together.

Although this system proposed by Mr. Currie is highly desirable, yet when we consider the enormous outlay it would involve, and the uncertainty of the return, we cannot but agree with Sir James Anderson, that it would not be advisable to scatter submarine cables in any such "broadcast manner." Nevertheless there is a good deal to be said in favour of certain parts of the scheme. A cable from England to Bermuda for instance, supplemented by another from Bermuda to New York rather than to Jamaica, is no new project. The present Brazilian cables were originally intended for this line, and it would not only be of imperial service, but in all probability a commercial success.

Sir James Anderson estimates that to connect St. Vincent with the Cape, *viâ* the West Coast settlements, would take 6,000 miles of cable, and to connect St. Vincent with the Cape, *viâ* Ascension and St. Helena, would take 4,500 miles. The latter cable would be laid in water from 2,000 to 3,000 fathoms, and in the course of the south-east trades. It would, therefore, be difficult to maintain, and Sir James is of opinion that no tariff could be established which would develop a traffic to make it remunerative. Although we admit the St. Helena route is open to these grave objections, we think the Coast route is much less so. By keeping closer to the Coast, so as to connect up the West Coast settlements, there is more likelihood of developing commerce and obtaining traffic, while the water is shallower and the region of constant trades is exchanged for that of variable monsoons. Of the two western routes we would, therefore, give the preference to that along the coast, although it might be fifteen hundred miles longer. There may not be at present sufficient commerce to justify the expense of laying so long a cable, but the recent discoveries of Stanley are certain to give an impetus to West African trade, and it will not be many years before such an undertaking will be warranted.

The need of a cable, connecting the Cape colonies to Aden, *viâ* the East African coast settlements, Delgoa Bay, Mauritius, and Zanzibar, finds more favour in the sight of Sir James Anderson. Owing to the growing commercial activity of these places, the connection of Aden to the whole world by the Red Sea and Indian Ocean Cables, and the fact that a tariff "unimportant as compared with any that could be arranged by the proposed Atlantic route" could be established, he is of opinion that the east coast route offers by far the greatest advantages. As a purely commercial speculation it undoubtedly does, but if we understand Mr. Currie rightly it is quite as much as an imperial one that he treats

the question. His wish is to have the advantage of an alternate route in case the Mediterranean cables should be interfered with. Sir James thinks that the "unquestionable advantage of alternate routes" should be sought in some other direction than the West Coast of Africa, and contends that they can be multiplied along the "course which commerce has already selected," viz., the Mediterranean and the Red Sea. We do not quite see how an additional line along the old course can properly be called an alternate route; nor how it can well be considered as a security if that route is open to attack. It appears to us that an alternate route is properly one in a different part of the world which may be safe, although the other is menaced or interrupted. However, in the words of Sir James, "this subject, in part, has already been submitted to our Government, and there we will leave it."

SIEMENS' APPARATUS FOR RECORDING ELECTRIC TELEGRAPH SIGNALS.

The object of this invention is to enable signals to be recorded by very weak currents, as in Sir W. Thomson's Siphon Recorder. Like the instrument just mentioned, the apparatus of Messrs. Siemens traces a continuous straight line on a paper strip so long as there is no current passing through the circuit, and this line is made to deviate to the one side or the other, according as a positive or a negative current is passed through the instrument. The means by which this is effected is as follows—

The paper strip has its surface on which the style acts blackened with finely divided carbonaceous matter, such as that deposited from smoke, so that as it is passed under the style the point of the latter, by removing the carbon along its line of contact, produces a white line (or of the same colour as the paper) on the blackened paper. For the purpose of blacking the paper it is passed over a smoking flame, and to prevent it from being ignited or charred, it is, during its passage over the flame, kept in close contact with a cylinder of metal or other good conductor of heat.

In order to fix the carbon coating on the paper strip after the line or signal has been traced thereon, so as to render the record permanent, the paper strip is treated with alcohol, ether, or other liquid, in which some resinous or glutinous substance is dissolved, it being for this purpose passed under a cylinder which dips into a bath of the liquid; and in order to accelerate the drying of the paper strip after it has been so treated, it may be passed over a wire gauze or other surface heated by a flame.

The movements of the style may be produced in any known manner. It may, for example, be attached to the tongue of a relay, or to a coil suspended in a magnetic field, as in Sir W. Thomson's instrument.

Fig. 1.

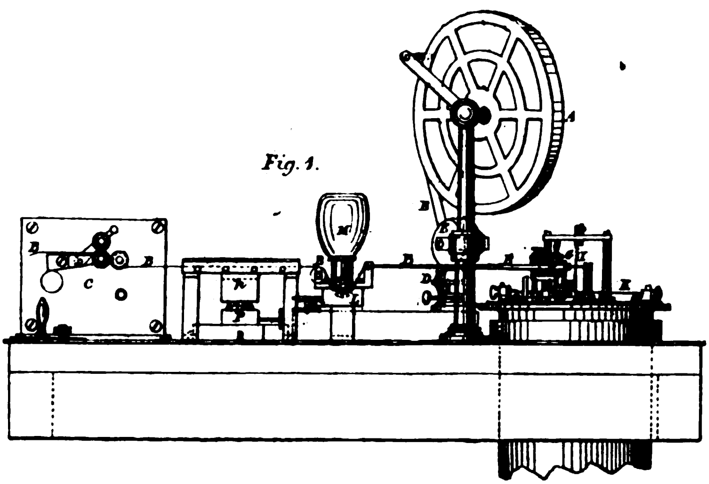
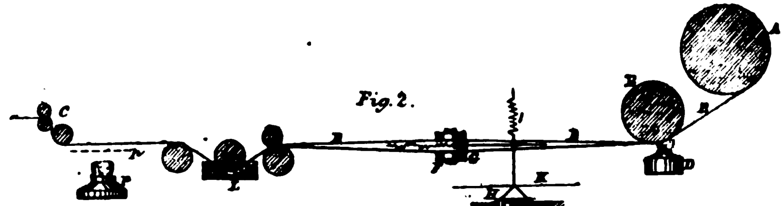


Fig. 2.



Messrs. Siemens also work the style by a coil in a circular magnetic field, which coil, for the sake of

lightness, is made of aluminium. It is suspended by a spiral spring, and in order to bring the coil rapidly back to the position of rest, and to prevent its lateral oscillations, elastic strings are stretched horizontally through the point at which the coil is attached to the spring, these strings serving as conductors for the coil.

Fig. 1 represents a general, and fig. 2 an outline view of the instrument. A is the reel whence the continuous paper strip B is drawn by the ordinary clockwork C. The paper B in its course from the reel A first passes over the smoking flame of a lamp D, above which is mounted the metal roller E, to prevent the over heating and scorching of the paper. The paper then is led over a roller F, between it and the tracing style G, which is attached to the bobbin H, of aluminium wire, suspended around the pole of the magnet N by a helical spring I.

In order to centre and steady the bobbin, two cross wires, only one of which, K, can be seen in the drawing, stretched by adjusting screws, are attached to it, and these wires serve as conductors. When electric impulses are transmitted through these and the coil of the bobbin, the latter is caused to move upwards or downwards in the magnetic field, and the traceing point G attached to it marks on the blackened paper B a wave line. From the roller E the paper is led under another roller through a vessel L (fig. 2) containing fixing liquid, which vessel is kept charged by a fountain glass M. The paper having been thus moistened is dried by being passed over the flame P of a lamp between which and the paper there is a screen *p* of wire gauze.

ON STRATIFIED DISCHARGES FROM A CONDENSER OF LARGE CAPACITY.

By WILLIAM SPOTTISWOODE, M.A., LL.D., Treas. and V.-P. of the Royal Society.

THE principal object of the following communication is to describe an instrumental arrangement which has proved very convenient for the production of steady striæ. The first attempt which was made nearly two years ago (February, 1876), consisted in charging a Leyden battery of nine large jars by means of an induction coil, and discharging it gradually through a vacuum tube. This was effected by connecting one terminal of the tube with the outside of the battery, and presenting the other terminal, made pointed, to a knob connected with the inside, at suitable instances. The following effects were then observed:

(1.) When the interval between the terminal and the knob was considerably greater than striking distance, the appearance in the tube was cloudy and apparently unstratified, or showed only faint indications of stratification. It was, in fact, very similar to that produced by attaching one terminal of the tube to one of an induction coil, and carrying the other to the earth.

(2.) When the interval was within striking distance, the usual jar-discharge without stratification or dark space took place.

(3.) When the interval was slightly greater than striking distance, but not so great as in the first case, a bright stratified discharge was observed. The proper motion due to a decline in tension was shown by a revolving mirror, and by a careful but rapid alteration in the distance during discharge, the motion could be arrested or even reversed. The duration of the whole, although long compared with a single flash from an ordinary coil, did not exceed half a second.

This experiment gave reason to hope that if a condenser of sufficient capacity were constructed, the discharge might be prolonged, and even varied, so as to allow an actual study of its various phases to be made.

The next attempt was made during last summer with some condensing plates, constructed for cable purposes, and kindly lent by Messrs. Latimer Clark, Muirhead, and Co. The results were in every way calculated to encourage further steps.

At the suggestion of Mr. De la Rue, and with the assistance of his battery for the purpose of testing the instrument, the same firm constructed for the experiments condensers of which the following are the particulars. Each condenser is contained in a box, and has a capacity of 13·8 microfarads, subdivided into ten sections, each section containing forty sheets of tinfoil, 18 in. by 13 in., insulated from each other by eight sheets of paraffined tissue paper. The superficial area of foil in each box is 1,300 square feet, and that of paraffined paper 14,166 square feet. It was found that these condensers could easily be charged with a 4-inch induction coil, worked by two Grove's, or even bi-chromate, cells. A much smaller coil would certainly suffice if the coil were made with a thick secondary, since $\frac{1}{4}$ to $\frac{1}{2}$ inch sparks are all that are required. In order to charge the condenser, one terminal of the coil was carried to outside of the condenser, and the other to the other with an intervening air spark. The object of the air spark was twofold: first to ensure that the tension of the electricity was sufficient to give the required charge to the condenser; and, secondly, to prevent the latter from discharging itself back through the secondary of the coil. After some trials, it was found that the air spark might with great advantage in steadiness of action be replaced by a vacuum-tube which offered sufficient resistance: such, for instance, may generally be found among those prepared for spectrum analysis, although these differ very widely in resistance. Lastly, the condenser was furnished with a safety discharger, consisting of a brass sphere and a point adjustible in distance from one another, so that the condenser might discharge itself at a suitable tension; *i.e.*, before the tension rose high enough to break down the insulation of the plates.

The discharge through the vacuum tubes on which experiments were being made was effected either by leading the two sides of the condenser directly to the terminals of the tube; or more often by leading one direct, and the other through the intervention of a resistance coil, such as was described in the Proceedings of the Royal Society for 1875, pp. 461-2. By altering the length of the resisting column as the tension in the condenser declined, the charge could be delivered through the tube at any required rate.

By this arrangement a steady stratified discharge can be maintained for one, two, or more minutes, according to the nature and pressure of the gas contained in the tube. In one case a nitrogen tube of 30 inches in length and 2 inches in diameter, a

special fixed phase was maintained for upwards of five minutes with one of the boxes above mentioned.

Speaking in general terms, the same connection between resistance in the circuit and the flow of the striæ as had previously been noticed with the induction coil and rapid contact-breaker (Proceedings of the Royal Society for 1875, pp. 458-9), was observed with this method; but the phenomena were exhibited with greater distinctness, and could be examined more at leisure.

In particular, with the nitrogen tube above mentioned, and other similar tubes, the direction of the flow reversed itself as the charge in the condenser became more exhausted. This was apparently due rather to a diminution in strength of current, or quantity of electricity passing through the tube, than to fall in tension, inasmuch as any particular phase could be maintained by gradually diminishing the resistance in the circuit as the tension declined. The penultimate phase was a forward flow from the positive terminal the ultimate a fixed condition of striæ. When sufficient resistance was interposed in the circuit, these striæ showed a faint indication of fissure into pairs of laminæ, and even actually broke into pairs by forward jerks. Very shortly after this the column became blurred, and the discharge then finally ceased. It should be further mentioned that by a suitable increase or diminution of resistance in the circuit the flow could be reversed again and again at pleasure.

It has frequently been noticed that in some tubes the column of striæ shows a tendency to mobility, while in others it is comparatively fixed; in one case it appears to be in a position of unstable, in the other in a condition of stable equilibrium. The former may generally be exemplified in hydrogen and nitrogen vacua, the lattter in carbonic acid, hydrochloric acid, and other vacua. Experiments recently made with another, in some respects yet more powerful method, tend to bring out the connexion between these two classes, an account of which is reserved for a future occasion.

Pursuing this subject further, the same experiments were repeated with an 18-inch, instead of a 4-inch coil, using as a battery either six large bichromate of potash cells, or, with still better effect, a large Gramme's machine, worked by steam. The results were in every way satisfactory. Tubes in which with the 4-inch coil the striæ were at best only imperfectly developed, or in which it was impossible to maintain the discharge for any finite time, were illuminated successfully in both respects; and in many cases the supply of electricity from the coil to the condenser could be so regulated as to maintain special phases for an indefinite time. The change of tint from pale salmon colour to violet gray in (impure ?) carbonic acid vacua, due to increased tension, as observed by Mr. De la Rue, with his great battery, were here displayed with great brilliancy.

The advantage of the 18-inch over the 4-inch coil consisted not so much in the tension as in the quantity of electricity given off to the condenser at each secondary discharge; and it seems probable that a coil specially constructed with very thick primary and secondary, and capable of giving sparks from ¼ to ½ inch in length, would be the most suitable instrument for the purpose. It would, of course, be necessary that the condenser should have sufficient capacity to act as a fly-wheel during the intermittance of the supply from the coil.—*Proceedings of the Royal Society.*

HASLER'S ELECTRIC WATER-LEVEL INDICATOR.

The electric water-level indicator, which had been fixed in 1869 to connect a reservoir on the Könizberg, with the gas and waterworks of the town of Berne, but which is no longer in use in consequence of the removal of these works, has worked well for seven years. However, its maintenance presented great difficulties in consequence of the extreme length of the double conduit (about a league), and from the nature of the mechanism establishing electric contacts. Of the 100 branches of the conduit, many were already in a bad state in the second year, and their failure caused derangements in the working of the apparatus, and the indicator gave false indications if the water-level changed during a repair. Also with the contact system employed, the current (furnished by 20 Meidinger cells) was liable to remain closed for several hours, and even days, when the water-level did not vary, and in consequence the battery would be hard worked. A battery which was employed at Berne to work 70 electric clocks, and the circuit of which remained closed for about 10 seconds every minute, had to be renewed every eight days, whilst a similar battery, employed in a hotel to work electric bells, did not require refreshing oftener than once in one or two years.

In order to avoid this continued contact inconvenience, M. Hasler has adopted for the new water service of Berne and of Lausanne (which takes its water from Lake Bret, distant about four leagues), a system in which contact is only made for about one second each time the water-level rises or falls by a certain fixed quantity; this system is shown by Fig. 1. On the axis A, behind the back part of the apparatus, is fixed the wheel R, to this is suspended the copper float F; the wheel has a circumference of $0^{m}.30$, so that when the float sinks $0^{m}.30$, the axis A describes one revolution; when the float rises the axis turns the opposite way by means of the counterpoise G, which is suspended to a second wheel rather smaller than the first, but fixed on the same axis. In front of the first wheel there is a disc S, with 10 small pins, which act, when the axis is rotated, like the buttons or stops of the bell of a clock; but, whilst in a clock the wheel which carries the stops acts constantly in the same direction in order to lift the arm to which the hammer is attached, in the present instance there are two arms, H and H′, which are severally acted upon according as the disc S turns in one direction or the other.

Upon an axis *a* moves a lever H′ with two arms, of which the left arm can be raised or depressed by the pins during the rotation of the disc. The right arm of the lever presses against a second lever *h′*, under the influence of the spring *f*. The lever *h′*, which also moves upon the axis *a*, normally rests on the adjusting screw L′. A hollow brass cylinder, M′, is suspended at the extremity of the lever *h′*; Q′ is an iron reservoir filled with mercury, and furnished

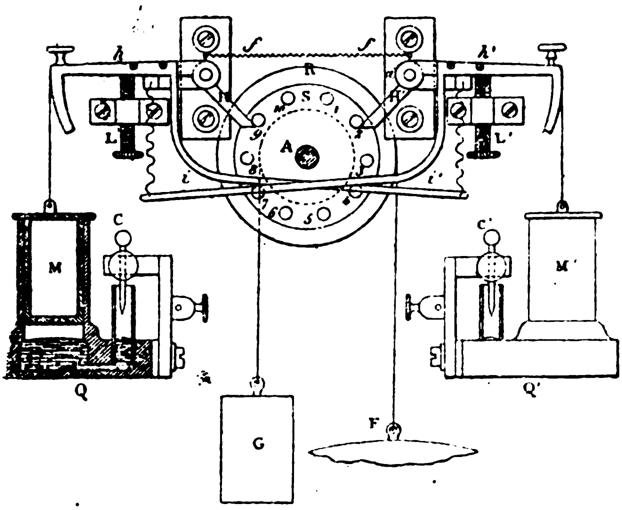
with two tubes communicating with one another, in the larger of which moves the cylinder M′, whilst the small one, formed of a straight glass tube, receives an insulated point C′, which serves to establish contact, and which is above the level of the mercury.

When the level of the water falls so that the float descends a distance of m.003 the disc S turns, the left arm of the lever H′ is pressed by one of the pins, the lever *h*′ is lifted at the same time with the cylinder M′, until the pin (2) escapes from the lever H′, and then the system of levers returns to its normal position. When the cylinder M′ falls, the air is compressed in the large tube, the mercury rises in the glass tube, contact is established for a moment, after which the mercury falls. If the float descends another m.003, a second contact is made, and so on.

each time, moves rather more than the opposite arm, which is pressed down at the same time by one of the pins. The two crossed arms *i*, *i*′, are fixed to the levers *h*, *h*′; the end of the arm *i*′ is connected with the lever H′ by a cord, and the end of the arm *i* in a similar way, is connected to the lever H. When a pin (2) depresses the arm of the lever H′, the lever H is lifted at the same time by another pin (9); before the first pin (2) descends, the arm of the lever *i*′ begins to act, and lifts the lever H above the pin (9) to a height such that when (2) descends the lever H can fall back in its position of rest in front of the pin (9).

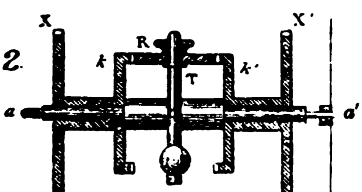
The indicator which shows the level is the same as that of the electric level of Siemens and Halske; on the axis *a*, *a*′ of the needle Z (Fig. 2) two crown

Fig. 1.



When the disc S turns the other way, that is when the float rises, the left branch of the lever H′ is lifted each time until it falls back to its normal position; but the lever *h*′ remains unmoved. At the

Fig. 2.



same time, when the float rises m.003, the lever H and *h* are lifted, and contact is established in C by means of the cylinder M.

When the level of the water rises or falls within the limit of m.003, the cylinders M, M′ move so very gently that the air cannot become compressed, and consequently contact cannot be established either at C′ or C.

In order to make the action of the apparatus certain, it is necessary, when the right lever falls back, that the left one should be brought again exactly at the same moment to its normal position. To obtain this requirement the arm of the lever, lifted up

wheels, X, X′, are attached to two ratchet wheels, *k*, *k*′, whose teeth are turned in opposite directions; these two former wheels gear with a wheel R running loose on an axis T, which traverses *a*, *a*′; so that one of the electro-magnets through which one current passes turns the wheel by means of an anchor escapement in one direction, whilst the propelment of the other magnet turns its wheel in the opposite direction, and the wheel R can thus be made to turn the axis *a*, *a*′ and the needle Z to the right or left.—*Musée de l'Industrie Belge.*

ON THE INTERPRETATION OF SOME EXPERIMENTS (OF FARADAY'S) RELATING TO THE INDUCTIVE EFFECT PRODUCED BY THE ROTATION OF A MAGNET ON ITS AXIS *

By S. TOLVER PRESTON.

1. A CURIOUS and interesting question is raised by some experiments of Faraday, described in the "Philosophical Transactions" in regard to the inductive effect attendant on the rotation of a magnet

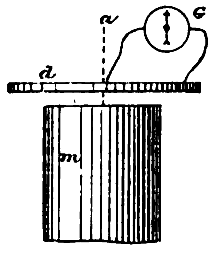
* From the *Popular Science Review* for January, by permission of the Author.

that experimental results rendered it necessary to draw a distinction between the motion of *rotation* and the motion of *translation* of a magnet, in regard to the behaviour of a system of force about it; for he says (Phil. Trans. 1852, p. 31.), "When lines of force are spoken of as crossing a conducting circuit, it must be considered as effected by the translation of a magnet. No mere rotation of a bar magnet on its axis produces any inductive effect on circuits exterior to it. The system of power about the magnet must not be considered as revolving with the magnet, any more than the rays of light which emanate from the sun are supposed to revolve with the sun. The magnet may even, in certain cases, be considered as revolving among its own forces and producing a full electric effect sensible at the galvanometer."

At the first sight it will appear theoretically a strange conclusion (and Faraday, himself designates it afterwards as "singular") that the above distinction between a motion of rotation and a motion of translation should hold. For even if we take the above illustrative case of the sun it must appear evident (as regards the light emitted from any luminous portion of the sun) that any effect that was produced by the translation of that luminous portion through space would equally be produced by the rotation of that same portion about the axis of the sun, for rotation *is* simply *translation in a circle*. So by the rotation of a magnet on its axis, its constituent parts are *translated* in circles. It would therefore seem necessarily to follow theoretically that any law that applied to the translation of a magnet would equally apply to its rotation. It is an observed fact that by the *translation* of a magnet, the inductive effect produced on external conductors is precisely the same as if these conductors were themselves translated with the same relative velocity past the stationary magnet, or the effect simply depends on relative motion. It would therefore seem a necessary influence that the effect by the rotation of a magnet also depended on *relative* motion, or that the inductive effect on any external conductor would be the same whether the conductor were moved past the periphery of the magnet, or the periphery of the magnet were (conversely) moved with the same relative velocity past the conductor (by the rotation of the magnet on its axis).

Faraday, however, appears to have considered that experimental results opposed this inference, for he concluded (as stated in the above quotation) that while the rotation of the conductor about the magnet produced an inductive effect on the conductor, the same relative motion of the magnet to the conductor (when the magnet rotates on its axis) produced no inductive effect on the conductor. The experiment on which this conclusion was grounded was as follows (Phil. Trans., 1832, p. 183):—

A circular disc of copper *d* was rotated on its axis *a* above the pole of a cylindrical bar magnet *m*. A wire *w*, in whose circuit a galvanometer G was placed, had one end maintained in sliding contact with the edge of the disc, and the other with the centre of the disc. It was found that the current given off by the rotation of the disc, and passing through the wire *w*, was precisely the same whether the magnet *in addition* was rotated on its axis in either direction, or remained stationary. Hence it was concluded that the rotation of the magnet on its axis produced no inductive effect on the disc, or (generally) that a rotating magnet could produce no "inductive effect on conductors exterior to it." Faraday adds, after a second perfectly similar experiment to the above, with a cylindrical copper cap instead of a disc (p. 184): "Thus a singular independence of the magnetism and the bar in which it resides is rendered evident." In other words, it was inferred that the system of force about the magnet could not be regarded as partaking of the motion of the magnet and crossing external conductors, when the magnet rotated on its axis. It will be observed that this necessarily involves the conclusion that, although the system of force emanating from the periphery of a magnet *admittedly* shares the motion (so as to cross external conductors) when the periphery is moved in the act of *translation* of the magnet, yet that it does not do so when the periphery is moved in the act of rotation of the magnet on its axis. It is difficult to see how this conclusion could be theoretically consistent, for what distinction can be logically drawn between



a motion of rotation and one of translation in this case, as by the rotation of a magnet on its axis its periphery is *translated* in a curve, and evidently a different law could not apply to the behaviour of a system of force according as to whether it is translated in a curved or a straight line. We should have considerable diffidence in criticising anything put forward by so eminent an authority, but scientific truth is admittedly paramount, and no one would claim immunity from an oversight. We think it may be distinctly shown that the above is an oversight resting on the rather curious accident that the particular experiment tried admits of a *double* interpretation. Thus, if we make no distinction between the behaviour of the system of force, whether the magnet is translated or rotated, or asssume that the system of force is invariably at rest *relatively to the magnet*, then by the rotation of the magnet on its axis the system of force accompanying the magnet will cross *both* the wire *w* and the disc *d*, thereby tending to generate a current in them both in opposite directions, so that there will be no current at all. This is therefore why the magnet, when rotated in either direction, produces no difference in the results. The final result is the same, not because the rotating magnet produces no inductive effect, but because the inductive effects upon the wire and disc *oppose* each other; or the rotating magnet causes an electric disturbance both in the disc and in the external wire in such a way as to produce a balanced static charge, so that no current is possible. To prove that the inductive effects in

on its axis. Faraday appears to have considered the disc and wire exactly balance each other, it is only necessary to rotate the wire and disc together through the lines of force of the stationary magnet, when there will be (as is known) no current in the circuit made up of the disc and wire, the effects in the disc and wire therefore exactly opposing each other. So, therefore, it becomes clear how the rotation of the magnet on its axis can make no difference in the results; and, therefore, the experimental result does not warrant the above singular distinction drawn in regard to the behaviour of the system of force when a magnet rotates on its axis.

Notes.

IT appears to be the inevitable fate of every "effete Britisher" who visits the United States of America, to become enthused over the "Institootions" of that great country. Pullman cars and monster hotels whirl away his self-possession, gin-sling and brandy smash take away his breath, the very Genius of Go-aheadism gets into his brain, the free air of the Rocky Mountains vivifies his blood, and the eloquence of Col. Jefferson Brick flows from his tongue. We still remember the eminent example of this amusing Yankee-mania, as we may call it, which was afforded us by Sir William Thomson, on his return from the Centennial Exhibition at Philadelphia in 1875. Sir William, as president of the Physical Section of the British Association, delivered the opening address to that section soon after his arrival home, and while he was still under the spell of America. The mind of the great physicist was evidently on the horns of a dilemma. While on the one hand it was labouring to produce a theory of the earth, on the other, it was struggling to give vent to the "big things" it had just seen across the Atlantic. The result was a remarkable production, whose head bristled with Yankee notions, and whose tail was composed of a profound dissertation on the rigidity, sphericity, fluidity, elasticity, and quasi-plasticity of the globe. Similarly at the meeting of the Telegraph Engineers on Wednesday, Feb. 13, Mr. W. H. Preece, in a lecture on "American Telegraphy," evinced that he too had caught the American infection, and the issue was a racy and entertaining discourse, in which the statistics of telegraphic progress were pleasantly interfused with tender memories of cock-tails and reminiscences of Niagara. Some of the specimens of American telegraphic terms which Mr. Preece drew attention to, were less calculated to excite our admiration than the practical novelties. We shall be happy to receive as many new instruments as our cousins can send us, but we must all wish that a kind providence may protect us from their nomenclature.

TELEGRAPHIC communication between Constantinople and Odessa, has been restored by the repair of the Black Sea Company's cable. The Turkish overland lines being occupied by the urgent interior correspondence of the Government, communication by this cable affords a direct service between England and Constantinople.

A MEMORIAL, signed by leading firms in New York, Philadelphia, and Boston, who are not in any way interested in existing telegraph cables, has, we are informed, been presented to both Houses of Representatives, asking Congress to secure the utmost facility of telegraphic communication between the United States and the rest of the world, by rejecting all applications for exclusive privileges, and passing a law giving permission to all persons and companies, without preference, to land telegraphic cables on the shores of the United States, and through them maintain telegraphic communication between the United States and other countries.

THE cable between Singapore and Batavia is interrupted, so that telegrams for Java, Australia, and New Zealand are, for the present, subject to delay. They are being forwarded by a steamer between the points of interruption.

THE West India and Panama Telegraph Company's repairing ship *Investigator* has successfully accomplished the laying of the new cable between Santiago de Cuba and Jamaica, thus duplicating that section of the company's system. The cable was manufactured by Messrs. Siemens Brothers, Charlton, and is reported to be in perfect electrical condition.

THE Great Northern Company's Cable between Nagasaki and Shanghai is restored. Messages are again received from all stations in China and Japan.

THE ELECTRIC LIGHT.—Some gunnery trials by night were recently made at Metz by help of the electric light, and under the surveillance of a committee of German military officers. Strong lights placed at a considerable distance from the targets rendered them distinctly visible even during a thick fog, and enabled the gunnery practice to be carried on successfully. It was found possible to light up small detachments of men out of rifle shot so well that artillery fire could be directed upon them. It is believed that the electric light may be made very useful in siege operations.

A SKATING rink at Hankley has been illuminated by the electric light.

THERE was great excitement all night long in the Place de l'Opéra last night. The experiments that have been some time in progress for lighting the exterior of the Opera House with the electric light were extended to the entire place. Eight lanterns, considerably larger than the gas lamps in ordinary street use, have been

erected on the Place de l'Opéra, four being on each side of the Boulevards. Beneath each of the larger lanterns are four smaller lamps, probably intended for service in the event only of some accident happening to the others. At all events, the latter were not lighted. The illumination from the eight lamps, and from the six small globes which have been on trial, was sufficient to make the neighbourhood of the Opera almost as light as day. The gas from the cafés and from the advertisements of various public amusements, which have hitherto made this the brightest spot in Paris, looked yellow and dull by the side of the pure white electric light. The ground glass of the new lanterns prevents the beams from being in the least dazzling, and there is none of that solution of continuity in the radiance which has been observed hitherto in all electric illumination. As midnight approached, the time for opening the doors of the Opera, crowds began to assemble, and the doorways soon became impassable, so dense was the throng of people who, attracted by the new experiment, waited to watch for the arrival of the maskers. To say sooth, these were few in comparison with gentlemen in ordinary evening dress, and ladies in black dominos and long mantillas. Nevertheless, the general effect viewed from the top of the grand central staircase, which is the glory of the building, was brilliant in the extreme; the bright colours of the fancy dresses standing out in splendid relief from the richly-hued marbles, and the rapidly-moving groups giving animation to the imposing scene. —*Daily Telegraph*, Feb. 18.

THE S.S. *Monarch* before leaving for the East is to be fitted with an electric light for torpedo work capable of sweeping the sea for three miles round.

THE Edison Phonograph was recently exhibited publicly to a crowded assembly in New York. The sounds produced by it were heard and understood in different parts of the room, especially those spoken with emphasis, and in a high key. Different voices were readily distinguished, and snatches of songs were reproduced with wonderful fidelity. The inventor confidently expects to perfect it, so that the performances of the best vocalists may be faithfully delivered by it at second-hand.

SIR WILLIAM THOMSON, in bringing the phonograph before the Royal Society, Edinburgh, recently, alluded to it as an elaboration of the electric pen. It appears to be a union both of the telephone and the electric pen.

TELEPHONIANA.—We hear that Mr. Spottiswoode finds that the telephone is audible without any diaphragm if the end of the magnet be placed close to the ear.

M. A. DEMOGET, of Nantes, contributes some further facts about the telephone. If one speaks into a telephone in circuit with the primary coil of a Ruhmkorff coil, the sounds can be distinctly received on a telephone in circuit with the secondary coil.

In order that the sounds transmitted by the telephones should be more easily perceptible, it is necessary that the plates should vibrate, as nearly as possible, in unison with the sounds emitted. This explains why the voices of women and children are best heard with vibrating plates from 3 to 5 centimetres in diameter, and the voices of men with plates from 6 to 8 centimetres in diameter. If the scale is sung into a telephone with a large vibrating plate, the first low notes will be easily heard, whilst the more elevated will be less distinct; if the vibrating plate is of small diameter the contrary will be the case, the most elevated notes will be most distinctly heard.

Two telephones can be put in a double circuit at one extremity of a line, and if a person speaks or sings into the two instruments simultaneously both voices will be heard in a single telephone at the other extremity of the line.

If in front of and at the distance of a millimetre from the vibrating plate of the telephone, we place one or two similar vibrating plates, taking care to pierce at the centre of the first one a circular hole of a diameter equal to that of the magnetised bar, and in the second a hole of greater diameter, not only the intensity of the sounds, but their distinctness will be increased thereby. By this means the vibrating mass is enlarged and the undulatory currents are intensified.

IN the *Comptes Rendus* for February 4, M. L. de Champvallier relates another instance of telephonic echoes similar to that recently reported from Providence, U.S. It appears that at Clermont, in France, there are two short telephonic lines, a line fifteen kilometres long from the summit of the Puy de Dôme to the Observatory of Clermont, and another fourteen kilometres long from Clermont to the village of Fontaine-du-Berger. These two lines are carried for ten kilometres on the same posts, being at a distance of at least eighty-five centimetres from each other. When speaking is carried on over the Puy de Dôme line, it can be overheard so distinctly, that it can be told whether it is a man or a woman who speaks, and even the words can be understood at times. It has been remarked that the messages sent from the Puy de Dôme are much more audible than those sent from Clermont, but this is probably due to the peculiarities of the voices of the speakers, or to the relative position of the stations.

M. NIAUDET proposes to use the telephone as a detector of extremely feeble currents, by means of an induction bobbin. The current is to be sent through the primary coil of the bobbin, and the telephone is to be in circuit with the secondary coil. If now the primary circuit be rapidly interrupted, the feeble current will give rise to sounds in the telephone.

At a recent meeting of the Royal Institution, Mr. Warren de la Rue, vice-president, stated that from experiments he had made, he came to the conclusion that the ordinary telephonic currents were feebler than the current from a Daniell cell through one hundred megohms resistance.

The Hon. Rollo Russell finds that for short distances, it is not necessary to insulate a telephonie line. Articulation and the tunes of a small musical box were heard by him over an uncovered copper wire circuit, laid four hundred and eighteen yards along the grass, the going and returning wire being kept well apart. Even when the wire was buried in wet clay for twenty yards, or immersed in the water of a pond for forty yards, talking in a low voice could be carried on without any appreciable loss of the effect obtained when insulated wires were employed.

Mr. F. J. M. Page, of the Physiological Laboratory, University College, finds that when the telephone is in circuit with the primary coil of a Du Bois Raymond induction coil, while the secondary is in circuit with a Lippmann's capillary electrometer, movements of the mercury column are found to accompany every word spoken into the telephone. It was found that the movement was always toward the capillary end of the electrometer tube, no matter in which direction the telephonic currents passed through the mercury; but this was proved to be due to the fact that the mercury tended to move *quicker* when a current passed towards the point of the capillary, than when it passed in the contrary direction, so that when a succession of undulatory currents is passed through it, the mercury moves towards the point in the capillary, its movement away from it being masked by its relative sluggishness in that direction. See the proceedings of the Physical Society in this number.

On Thursday the 21st. ult., Mr. Childers asked the Postmaster-General whether his attention had been called to the use of the telephone by telegraph departments and companies abroad; and whether it was his intention to introduce it into the postal telegraph service. In reply, Lord John Manners said that the use of the telephone had been brought under his notice, and an inquiry into its merits had been made by the officers of the Post Office. The results, however, were such as to render its use, at present, unsuitable for the postal telegraph service.

An Electrical Storm in California.—A correspondent of our American contemporary, the *Operator*, writes as follows :—An unprecedented electric and sand storm has visited this portion of the country (Tulare, Cal., Jan. 18.), entirely prostrating the wires of the S.P.R.R. at and around this place. The storm was of over three hours' duration, lasting from eleven a.m. until two p.m., during which time lamps had to be lighted, it being impossible to distinguish the outlines of a box car six feet away. The air during the storm was so thickly impregnated with electricity, that one received a slight shock on merely grasping hands. On the approach of the storm, which could be heard several miles away, we cut out the instruments and disconnected the office connections leading from the main lines, but that proved a failure as regards obstructing the electricity, as the minute the storm struck, the cut outs emitted a crackling sound, followed by sheets of flame three inches in length from the cut out points. Some of these jumped from the cut out to the instruments, a space of over seven feet, and partially fused the instruments. On going into the freight house, the roof was discovered to be on fire in several different places, caused by the wire being in contact with it; and finding it impossible to quench the fire, or to touch the wires to remedy the evil we were forced to sever the lines from both ends of the building, or sacrifice it.

Since 1870, the telegraph work in Glasgow Post Office has been nearly doubled. In one week in that year, the number of messages forwarded from Glasgow was 5750, the number received 7379, and the number transmitted 7157, making the total number of messages passing through the office 20,286. In the week ending 2nd February this year, the messages forwarded numbered 12,107; received 12,541; transmitted 15,874; total 40,522.—*Iron.*

Telegraph offices have been opened at Hamble (Southampton); Sidcup (Chislehurst), Warriston (Edinburgh).

Fifteen insulated wires, enclosed in an iron pipe, boxed in to protect it from injury, have just been laid across the New Tay Bridge.

We learn from the American medical journals that Electrolysis has recently been successfully applied to the reduction of tumours in the ovary.

Hodgson's Railway Signals.—At the ordinary meeting of the "Society of Engineers" on the 4th ult., Mr. R. P. Spice, president for the year, delivered his inaugural address. After alluding to Cleopatra's Needle, the telephone, and the electric light, he said:—"I cannot pass by without notice an invention which is of great importance in the working of our railways, and which was brought under public notice towards the close of last year. This is the union of the block and interlocking systems, which has been ingeniously effected by Mr. Hodgson, the manager of Messrs. Saxby and Farmer's Railway Signal Works at Kilburn. The two systems mentioned, if properly worked, afford, on the one hand, a perfect command over points and signals by the interlocking arrangement, and on the other, by the block system, perfect immunity from accidents by collisions, the trains being kept a definite distance apart. But the two systems are worked in-

dependently, and are mutually dependent on each other. There is room for human fallibility to step in and create disaster, and it has more than once done so. By the union of the two systems, however, it would seem to be impossible for accidents to occur, save from the wilful disregard of signals by the drivers of trains. Mr. Hodgson's is a clever mechanical combination of the interlocking and block systems, in which both systems are operating at the same time, and are made to work co-incidently. The invention thus carries the security of the interlocking system a step further, the levers of the points and signals and the handles of the telegraph instruments being interlocked reciprocally, with the result that there cannot be any contradictory working between the out-door signals and points, nor between them and the train telegraph signals transmitted electrically. The system has been approved of by the Board of Trade, and has already been adopted on the London and Brighton Railway."

Patents.

570. "Gyrometers for marine engines and other motors (electro magnets and clockwork)." — W. MORGAN BROWN (communicated by Schaffer and Budenberg). Complete.

596. "Improvements in applying electricity, and apparatus connected therewith." — G. B. BRIGHT, Feb. 13.

609. "Circuit closers for torpedoes." — M. H. ATKINSON, Feb. 13.

610. "An improved electric apparatus for mastering horses."—A. ENGSTRÖM, Feb. 13.

611. "Electro telephonic apparatus."—A. G. BELL, Feb. 14.

617. "Telephones, or instruments for transmitting and receiving articulated and other sounds by electric telegraph."—H. J. HADDAN (communicated by G. B. Richmond), Feb. 14.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

833. "Improvements in electric telegraph apparatus, and in insulated electric telegraph conductors, and pipes or troughs connected therewith." — W. T. HENLEY, dated March 1, 1877. 6d. This consists in improvements in Henley's Alphabetical Instrument (described in Patents, No. 734 of 1861, and No. 2464 of 1861) whereby the operator is prevented from indicating the wrong letter. It provides for improvements in electric bell alarms, whereby a current is sent through an electro-magnet or needle coil, which detaches a detent and allows a lever with weight at the end which has previously been kept at a nearly upright position to fall against another lever which may discharge a train of clockwork arranged to strike any number of strokes on a bell, or ring a bell of any size. The patent also describes an inexpensive and efficient and durable insulating material, formed of a compound of gutta-percha and cotton seed pitch, preferably equal proportions. India-rubber may be mixed with these ingredients, but india-rubber and cotton seed pitch have been previously employed together. The compound in question can be made by heating, masticating, and rolling the materials together, and applied to the wire in a plastic state. Improvements in a protecting trough for insulated wires laid underground are also included.

851. "Improvements in electric telegraph apparatus particularly applicable to submarine cables of great length."—FERDINANDO TOMMASI, dated March 2, 1877. 10d. This apparatus is fully described in the TELEGRAPHIC JOURNAL for Feb. 1st and 15th.

855. "Improvements in protecting submarine and subterranean telegraph cables and wires from the destructive effects of toredo white ants and other marine and terrestrial animalcule and insects."—COL. T. G. GLOVER, R.E., dated March 3, 1877. 2d. This consists in winding a strip of lead foil spirally round the core of the cable, so that its edges overlap a quarter of an inch; and in covering the lead foil with a serving of hemp saturated with castor oil. The outer hemp serving of the cable to be also steeped in castor oil. *(Not proceeded with).*

902. "Improvements in thermo-electric batteries."—CECIL and LEONARD WRAY, dated March 6, 1877. 6d. This consists in improvements on Wray's Thermo-pile (Patent No. 976, of 1867). To prevent the thermo-electric bars from cracking (as bars of bismuth and zinc alloy almost invariably do) an alloy of antimony, zinc, and iron, is used in the proportion of from one to five per cent. of finely divided iron, preferably cast, according to the special purpose of the pile. The iron increases the strength, hardness, and infusibility of the bars. To further prevent the bars from cracking, non-metallic moulds of earthenware, clay, &c., are built up of pieces embedded in sand and loam. The third part of this invention consists in enclosing the bars, when built up into a pile, in clay or other suitable substance in order to protect them from external injury and to enable them to heat and cool down gradually.

1023. "Improvements in apparatus for electro-plating wire."—W. WALLACE, Ansonia, Con., U.S, dated Mar. 14, 1877. 6d. This consists in placing within the bath a slowly revolving shaft carrying the coil of wire to be plated so disposed that all the parts of the wire will be equally exposed to the action of the bath. Thus a uniform and perfect coating of the wire is obtained.

1116. "Improvements in electric batteries, together with the mode of and apparatus for separating iron and other metals from their ores, and in generating electricity and thermo-electricity by or during the electro-deposition of such ores."—W. B. BRAIN, dated March 21, 1877. 4d. This consists in forming a cell composed of an outer vessel of iron, and two inner porous chambers of flannel, &c., one within the other. The space between the two chambers is filled with hematite iron ore; the inner chamber is filled with carbon. Electrodes are fixed to the carbon, ore, and iron vessel. The carbon is steeped in a mixture of nitric, sulphuric, and chromic acids. The ore is steeped in hydrochloric acid and chloride of ammonia. The ore, it is stated, will be found electro-positive to the iron and electro-negative to the carbon, or, in other words, a current will pass from it to the iron, or to it from the carbon. Chloride of iron is formed. The action is considerably increased by heating. To deposit pure iron the outer vessel is made of zinc, or zinc is put in the place of the carbon if the iron vessel is retained, and chloride of iron solution is put in place of hydrochloric acid and chloride of ammonia.

1273. "Improved apparatus for generating and applying electricity for medical purposes."—G. EDARD, Paris, dated March 31, 1877. 8d. As set forth, this invention consists "in providing a source of permanent static

electricity, one element of this dry pile being formed by an electro-magnet of suitable form and dimensions embedded in magnetic iron ore in the form of dust or sand. Several elements are combined together to form electric friction brushes, belts, corsets, abdominal supports, garters, hose, bonnets, and other bodily appliances."

Correspondence.

THE CONTACT THEORY OF VOLTAIC ACTION.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—When contributing his paper, "On the Difference of Potential produced by the Contact of Different Substances," to the Royal Society, on May 22nd, 1877, Professor Clifton, of Oxford, seemed to be quite unaware of the elaborate series of experiments on exactly the same subject made by us in the winter of 1875, a full account of which was communicated in a paper on "The Contact Theory of Voltaic Action, paper No. 1," to Prof. Sir W. Thomson, May 6th, 1876, who at the British Association meeting at Glasgow of that year gave a public account of the method employed by us and the results we obtained, reserving our complete paper for the pages of the proceedings of the Royal Society.

If the investigation in question had been of merely ordinary importance we should not have deemed it necessary to point out the priority of our experiments to those of Professor Clifton; but when the fact is remembered, a fact not very evident from Professor Clifton's paper, that a series of experiments such as we performed, clears up the long standing discrepancies between the chemical and contact explanations of voltaic phenomena, and so is of extremely great importance in the science of energy, we trust we may be pardoned for claiming the priority due to us. Much of the ordinary original work performed in physical laboratories must, of course, be undertaken nearly simultaneously in different countries, and our great distance from Europe necessarily places us in the unfortunate position of being some months in time behind other men who publish papers in the same societies as ourselves; but in this particular case the work was not of an ordinary kind, and we have not to ask for the indulgence of scientific men in making allowance for our residence in Japan, seeing first, that our paper reached England exactly one year before Professor Clifton's communication was made to the Royal Society, and secondly, that Sir W. Thomson was so kind as to give an account of our method and results to the British Association several months before Professor Clifton appears to have commenced his earliest experiments on the subject.

The method of experimenting employed by this gentlemen is essentially the same as that used by ourselves with this important difference, that whereas Professor Clifton only removes the plates of a condenser from a distance a apart to a distance b apart, we removed them to an infinite distance apart, and then put them in such a position that the original charge to be measured was doubled; so that, in fact, our method was by far the more delicate, and was only limited in sensibility by the natural imperfections of mechanism. All this was clearly shown in the carefully executed drawing that accompanied our paper. The advantages we derived from the superior delicacy of our apparatus are seen if we examine, as may be easily done, the two papers, paragraph by paragraph, for—the metals and liquids employed by Professor Clifton being the same as those used by ourselves—in every case that he, in 1877, was only able to detect the sign of the difference of potentials, we, in 1876, published not only the sign but also the numerical value of the difference in question (compare pages 301 to 305 of his paper, in the Proceedings of the Royal Society, No. 182, with our paper). Considering too, that the quantities of electricity to be measured are so small, and consequently the slightest loss of electricity is so serious, we fail to see what benefit was derived from using six insulating stems instead of only two carefully protected insulating rods of our apparatus.

We observed that Professor Clifton assumes throughout his paper "The Summation Law of Electromotive force," and that he was compelled to make such assumptions in consequence of his inability to measure *directly* with his apparatus the difference of potentials between two *liquids* in contact. But if this law be assumed, then we might have employed in our research the method of measuring the difference of potentials of two liquids in contact that we had often, as early as 1874, employed as a lecture illustration to indicate this difference.

This method consisted in attaching to the terminals of a quadrant electrometer, two platinum wires, of which the ends were respectively dipping into two liquids separated by a porous diaphragm; but to make use of the observations obtained from such an experiment, it must be assumed that the observed deflection of the electrometer represents the algebraic sum of the three contact differences of potentials, such as might be measured separately. At first sight, not to assume this, might appear to be a refinement of caution on our part, but in reality it was imperative to prove experimentally that this assumption was true, when it was taken in connection with the statements generally made by the supporters of Thomson's theory of contact. For example, Professor Fleeming Jenkin says, on page 44 of his "Electricity and Magnetism":—"When a single metal is placed in contact with an electrolyte, a definite difference of potentials is produced between the liquid and the metal. If zinc is plunged in water the zinc becomes negative, the water positive. Copper plunged in water also becomes negative, but much less so than zinc. If two metals be plunged in water (as copper and zinc) the copper, the zinc, and the water forming a galvanic cell, all remain at one potential and no charge is observed on any part of the system." Consequently in 1875, we discarded our original proposed method of experimenting which was to use an apparatus somewhat similar to that employed by Professor Clifton, as far as we can understand it without a drawing, and we constructed the apparatus described in our paper, which enabled us to measure any single contact difference of potential whether of a metal with a metal, or a metal with a liquid, or a liquid with a liquid, or a combination of any two or more contacts.

The very important fact that the rise of the difference of potentials between the plates of a voltaic cell, on first immersion when the circuit remains open, is due to the same cause as polarisation of the plates when the circuit is closed, but operating in the opposite direction as explained by Professor Clifton, was clearly stated by us in our paper in question under the head of "The Three States of a Cell," and our subsequent papers showed that we considered this effect to be analogous with the so called soaking in and soaking out in any dielectric, or what is called the residual charge in a Leyden-jar, a subject to which we have been since devoting much attention; but we even went further, for we found that even when the circuit was closed

directly after immersion, there was first a rise of difference of potentials followed afterwards by a fall, and this in an explanation of the want of constancy observed in many cells, and notably in the two-fluid cell described by Professor Clifton, page 309.

We take the liberty of observing that, although a table of the difference of potentials of the terminals of different cells is of great value to practical men, still we should hardly have expected to find such a table at the end of Professor Clifton's paper, with only one number (almost without exception) given for each cell, since he was quite aware that the difference of potentials between the electrodes alters from the first instant of immersion of the plates. Again, we do not understand how he can say that no current has passed, for it is evident that a current may pass without the electrodes being externally connected. A table such as is given by Professor Clifton would be very valuable if it gave the difference of potentials between the electrodes when the plates had been immersed for a sufficient length of time for the difference of potentials to reach its maximum value, but it would be more valuable if it gave the time rise of the difference. We confess, however, that it is only with exceptional cells that we have succeeded in getting on different occasions exactly the same results with the same combination. Such a table as we suggest, which would be a great improvement on that given by Professor Clifton, could of course be constructed by any one possessing an electrometer without any special apparatus.

In conclusion, we notice, page 299, that Professor Clifton sees the necessity of changing his apparatus, which could not measure directly the difference of potential between two liquids, before he can obtain satisfactory measures of the difference of potential in certain important cases. We may mention that, although we measured with considerable accuracy the difference of potential of several pairs of liquids with our apparatus, as described in our paper of 1876, still we thought it advisable, in the summer of that year, to construct a new apparatus, the accurate results obtainable with which will form the subject of our next paper on this subject.

We beg to remain, Sir,

Very truly yours,

W. E. AYRTON.

JOHN PERRY.

The Imperial College of Engineering,
Tokio, Japan.
December 14th, 1877.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

AT an Ordinary General Meeting, held on Wednesday, the 13th inst., at the Institute of Civil Engineers, Professor ABEL, C.B., F.R.S., Past President, in the chair, a very interesting paper was read by Mr. W. H. Preece, Vice-President, on "American Telegraphy."

It will be remembered that, during the spring of last year, Mr. Preece and Mr. H. C. Fischer, of the Postal Telegraph Service, were commissioned by the Government to proceed to America for the purpose of reporting upon the various systems in operation there.

Leaving Liverpool, per *Abyssinia*, on the 4th of April, 1877, Messrs. Preece and Fischer arrived in New York on the 14th of that month. Here they were well received; and Mr. Preece speaks loudly in praise of the frank manner in which the various telegraph authorities threw everything open to their inspection.

After "doing" New York, our Commissioners proceeded to Philadelphia, Baltimore, and Washington; thence crossing the Alleghany Hills to the valley of the Ohio and to Cincinnati, they proceeded to Indianapolis and Chicago. From Chicago they entered Canada (visiting Niagara, *en route*, of course), and passed successively through Montreal, Quebec, Portland, and Boston to New York. The whole tour in America occupied about three weeks.

Mr. Preece, before passing to the real business of his paper, gave a short and humorous description of his experiences in travelling, specially mentioning hotels, railway-cars, and river steamers. *Apropos* of railways, it was observed that there is an almost entire absence of railway signals in America.

The constitution of American telegraph companies is somewhat different to our own. The president of the company is not only chairman of the board of directors but also general manager—in fact, both administrative and directive head. The vice-president also takes distinct administrative duties; they are joint executive officers.

The telegraph system of America is a very large one. Exact statistics are difficult, if not impossible, to obtain, partly because an enormous number of companies have been started at various times, some of whom do not publish their accounts, and partly because different States keep their accounts in different ways.

In the United States and Canada there are, altogether, some 300,000 miles of wire. The Western Union Company have about 195,000; the Atlantic and Pacific Company, 36,000; The Montreal Company, 20,000; the Dominion Company, 7,000; smaller companies and railways, 40,000. There are some 11,660 stations; and, during the last year, 28½ millions of messages were carried.

Embarked in this enormous enterprise is a sum of 60 million dollars (£12,000,000) of capital; the amount of capital lost it would be difficult to estimate. Some idea of the number of ventures which have been started from time to time and absorbed may be gathered from the fact that the Western Union Company alone comprises over 200 smaller ones.

Local companies are numerous, such as the Gold Stock Company of New York (similar to our Exchange Company), the Law Telegraph Company, which enables lawyers to hold consultations with each other and with their clients without leaving their offices, district companies, &c. Then there are the railway companies' telegraphs, and about 2,500 miles of military telegraphs, which render good service in reporting meteorological changes, and in foretelling storms.

The tariff in the United States is very anomalous. A ten word basis is adopted, and free address of receiver is allowed, the sender's signature only being telegraphed. Beyond ten words, messages are charged at per word. There is a "local tariff" for short distances:—25 c. for 25 miles or under, 50 c. for more than 25 but not over 50 miles. Then there is the "square" rate, which is as follows: The whole country is divided into squares of 2,500 square miles each. Then the tariff from any place in one square to any place in another square is computed upon the air-distance between the centres of the respective squares. For distances beyond 1,000 miles, however, another rate comes in, called the "state" rate, based upon the distance between the respective states. In addition to these there are "special" rates, "half-rates," and a number of others, the whole being very puzzling to a foreigner.

In England, pre-payment of messages is compulsory; but in America they have "collect" messages, the payment for which is collected on delivery. This is one of

the bad results of great competition. There is another feature wherein their practice differs from ours, viz., "deferred" messages, which are messages handed in one evening for delivery next morning. This is a valuable privilege to the public in places a long way apart, and separated by two or three days' post. The result is that between New Orleans and New York 42 per cent. of the traffic is done in "deferred" messages, while at Baltimore the proportion is only six per cent. Of the total Western Union traffic, 13 per cent. is "deferred."

Comparison between the two countries is difficult; but, practically, telegraphy is cheaper in England than in the States, the ratio being as 1s. to 1s. 10½d. On the other hand, the average distance in America is seven or eight times the English. Press arrangements are not superior to ours. News is collected by a Press Association, and carried by telegraph companies at low rates, viz., 1 c. to 10 c. per word, the lowest being 1 c. per word for 500 miles. Additional copies are supplied to newspapers at half-rates. The average rate for a message from the Press Association to a newspaper in any part of the States is 4s. for 100 words, extra copy 2s. In England these are 1s. and 2s. respectively; and consequently we do more press work than they do in America. In England, on an average, 700,000 words are transmitted nightly, and two millions of words are delivered to newspapers every morning, being about ten times as much as in the United States.

American companies are obliged to carry Government messages at 1c. per word per 500 miles; and a large business is done in this direction, as also in free messages which form a large per-centage of American traffic.

The telegraph service is quite a favourite one in America, and it is quite the exception there to meet a person who knows nothing about telegraphy. At Harvard, the undergraduates have their services of telegraphs, and form themselves into companies, it being quite an honour to belong to the leading companies. Telegraphy being used to a large extent on railways, the railway servants are mostly accustomed to it, and there are few station-masters who have not at some time or other been operators.

There is a large demand for operators in the various companies, and consequently a plentiful supply. The pay is good, the average salary of an operator in the Western Union Co. being £192, while in England it is only £80. Great pride is taken in the work and many of the operators become very skilful. Mr. Preece does not consider the scientific attainments of the staff equal to that of the English staff, a fact which he attributes to the absence of submarine cables.

Females are employed by the American companies, though not to so large an extent as in England.

The alphabet in use in the States differs slightly from ours, some of the letters being "space" letters, *i.e.*, letters in which the dots or dashes are separated by a space equal to a dash. This system is probably slightly quicker than ours, but Mr. Preece considers it leads to more errors.

With regard to engineering details, the American lines are chiefly characterised by extreme simplicity and uniformity in the stores used and in the manner of performing the work. In the early days of telegraphs the railways were seized by the first companies, later comers being driven to the roads; both are now plentifully covered with lines. The average cost of a one wire line is from 100 to 150 dollars per mile, not much more than with us. Very little underground work is used, but on the other hand street work is far too commonly resorted to. Mr. Preece was strong in his denunciation of the unsightly lines of wires which, even more than here, disfigure the best streets of large towns. No thoroughfare, however beautiful, is free from invasion by telegraph companies; in some places two or three rival lines exist side by side in the same street. For some of these town lines poles of enormous height are used. In New York and Philadelphia there are poles 90 to 96 feet high, and in Chicago 75 feet. These gigantic poles are, of course, erected at great cost.

(*To be continued.*)

THE INSTITUTION OF CIVIL ENGINEERS.

AT the Meeting on Tuesday the 12th of February, Mr. BATEMAN, President, in the Chair, the Paper read was on "The Evaporative Power of Locomotive Boilers," by Mr. J. A. Longridge, M. Inst. C.E.

In this communication the author endeavoured to set at rest certain widely diverging opinions which existed among practical men, with reference to the evaporative efficiency of the various elements of a locomotive boiler; such as, the area of the fire-grate compared with the total heating surface, the ratio between the tube surface and the fire-box surface, and the rate of combustion per square foot of fire-grate. The cause of such divergence of opinion was due to the multitude of variable conditions; and it was only by embodying these in a symbolic formula that the relative effects could be estimated.

After adverting to Mr. D. K. Clark's formula, $w = a r^2 + b c$, and pointing out that, from its empirical nature, it was only applicable within certain limits, the author investigated a new formula, based upon well known physical laws and mathematical principles. Assuming any given consumption of fuel per hour, the amount of heat generated was first determined; then, from the laws of the transmission of heat through plates, the quantity which passed through the fire-box surface into the water was deduced, and from what remained, the temperature of the gases entering the tubes was found. From this the loss of the temperature in passing through the tubes was calculated, based upon the same law of transmission, and thus there was obtained the temperature of the gases in the smoke-box. From the loss of temperature in passing through the tubes, the evaporative effect of the tube surface was ascertained, and this, added to that of the fire-box, gave the total evaporative effect of the boiler.

From the author's formula the evaporative powers of twenty engines were calculated, and the results compared with actual experiment and with those given by Mr. D. K. Clark's formula. It was shown that the tube surface was a very important element, and that on an average the tubes effected nearly 80 per cent. of the whole evaporation. Also that the generally-received idea, that 1 foot of fire-box surface was equal to 3 feet of tube surface, was fallacious; indeed the proportion was very variable, for while, in the "Ixion," 1 foot of box surface was only equal to 1·7 foot of tube surface, yet in No. 33, Caledonian Engine, 1 foot of box surface was equal to five feet of tube surface. Consequently no fixed ratio could afford a safe rule for practice. It was then demonstrated that the length of the tubes had nothing to do with economy of evaporation, but that this depended simply upon the ratio between the consumption of fuel per hour and the total absorbing surface. The question of the diameter of the tubes was next discussed, the late Mr. Zerah Colburn's views being dissented from; and it was shown that the diameter was a matter of no consequence so long as the proper amount of surface was obtained. The same remark might be made regarding the ratios between the fire-grate and the heating surface. It was not the area of

the fire-grate, but the weight of fuel consumed per hour, which had to be considered; and as regarded economy of evaporation, it mattered little whether 50 lbs. of coke per square foot per hour were burned in a grate of 20 square feet area, or 100 lbs. per square foot per hour in a grate of 10 square feet area. In each case, if the absorbing surface were the same, the economy of evaporation would be the same.

The question, how far the combustion of fuel was perfect, was then examined; and it was pointed out that in many cases it was very far from being so, some French experiments exhibiting losses of from 22 to 39 per cent.

The general conclusions arrived at might be thus summed up:—that no fixed rule could be established as the best for the relative proportions of the fire-grate, fire-box, and tube surfaces; that length of tube had nothing to do with economic effect; that the diameter of the tube was also a matter of indifference; that economy of fuel did not depend upon the rate of firing; that when the quantity of fuel burnt was moderate, say 50 lbs. or 60 lbs per square foot of grate per hour, the combustion was nearly perfect, while with hard firing there was considerable loss from carbonic oxide passing away unconsumed; and that a large increase of heating surface in proportion to coal burnt only slightly increased the economic effect, which within the limits of practice in locomotive engines was nearly in proportion to the fourth root of the heating surface.

In the discussion which followed, and which was continued on Tuesday, the 19th of February, most of the speakers expressed their sense of the value of the Paper, and their concurrence in many of the views enunciated in it. Mr. Clark said that his formula had been constructed from the results of three hundred experiments. Mr. Bramwell pointed out that in former times, when coke was the fuel employed, the area of the fire-grate was an important element, as affording the only means of access of air; but that, now, as the use of coal necessitated the admission of air in front to ensure combustion, the area of the fire-grate was of little consequence. Fuel might be applied in the solid, liquid, or gaseous state; in the latter state the surface exposed to combustion is infinite; in the liquid state the surface exposed is very great; but in the solid state the surface exposed depends entirely on the size of the pieces of fuel; and Mr. Bramwell affirmed that the efficiency of combustion depends largely on the method of firing, and that it is greatest when small amounts of fuel are being constantly put on; but that as such a method conducted by manual labour, would involve too great expense in wages, mechanical means of firing should be devised. He remarked that for economy in combustion an excess of air was preferable to a deficiency; and he advocated a series of trials of locomotives being made similar to those instituted for agricultural engines by the Royal Agricultural Society, which had been attended with such excellent results. One speaker observed that no such trials were needed, as all locomotives were under constant trial in the usual course of working, and that promotion was granted to the men mainly for economical firing. Another speaker said that the adoption of the amount of fuel consumed, as a standard of comparison, was like estimating a man's value by the wages he received instead of by the amount of work he accomplished, and that the quantity of water evaporated should be taken as the standard. Mr. Longridge, in reply, expressed his opinion that it was thoroughly established by experiment that the combustion was equally efficient, whether the firing was done gradually or in a mass. He considered his formula applicable to all cases, whereas an empirical formula, like Mr. Clark's, failed in certain instances to give correct results; and he claimed for his Paper the merit of practical utility, as affording a ready means of ascertaining the most advantageous dimensions for the various parts of locomotive boilers.

PHYSICAL SOCIETY.—16th FEBRUARY, 1878.

The President, Professor W. G. ADAMS, in the chair.

THE following candidate was elected a member of the Society:—Mr. G. H. West, M.A.

Dr. LODGE read for Mr. H. F. Morley, M.A., a paper on "Grove's Gas Battery." After referring to the views of M. Gaugain and Mr. Grove himself with regard to the cause of the action of this apparatus, the author proceeded to describe an elaborate series of experiments he has recently made in order to ascertain the circumstances by which it is regulated. It would be impossible to give a clear account of them in a short space, but some of his conclusions are as follows:—The whole of the current is due to dissolved gas, and if n be the distance of the level of the liquid from the top of the plate in the H tube, and $E = \frac{C R}{1000}$, C being given in galv. readings and R in ohms, he finds that, approximately, $(1 + n a) C = b + n e - (c + n d) E$ where a, b, c, d, and e are constants. The electromotive force is not constant, but rises with the resistance. The current is greater in proportion as the gas present in the elements is less; and, finally, the current appears to vary directly with the pressure.

Mr. S. C. TISLEY then described the harmonograph, specially referring to its use for drawing pairs of curves for the stereoscope. This, the latest form of his pendulum apparatus, is capable of giving a very great variety of curves, for, in addition to rectangular vibrations, parallel and elliptic motions can be combined by its means. In the older form of apparatus each pendulum moves on the other as a centre, whereas in the instrument described they are independent. One pendulum carries at its upper end a table which can be caused to rotate by clockwork if required. The whole is supported on a kind of gimbal-joint formed of two pairs of knife-edges at right angles, so arranged that vibration can take place either on one or the other, or the two can be so combined as to give a circular motion; or, again, the pendulum can be caused to vibrate in any given plane. The second pendulum vibrates in the plane in which the two hang, and carries at its upper end an arm terminating in a pencil over the table of the other pendulum. A very ingenious adjustment renders it possible to raise or lower the bob of the second-named pendulum during its motion. If two pens be attached, about $2\frac{1}{2}$ inches apart, instead of the single one usually employed, and two curves be traced, they are not precisely similar, and when viewed in a stereoscope they are found to give the well-known appearance of solidity to the figure. It was further shown that by gradually changing the relative motions of the pendulums it is possible to impart to the curve many of the forms observed in biaxial crystals in the polariscope.

Mr. F. G. M. PAGE then exhibited the action of the telephone on a capillary electrometer. The construction of Lippman's Electrometer, as modified by Marey, was first explained, and the meniscus of the mercury in the capillary tube was thrown on the screen by the electric light. The delicacy of the instrument was shown by passing a current of $\frac{1}{1000}$ of a Daniell, which caused a distinct movement of the mercury. Resistance of 5000 ohms and $\frac{1}{50}$ ohm gave approximately the same deflection: so that, in practice, the instrument

may be considered to be independent of resistance; in addition to which it possesses the great advantage of portability, and its indications are almost instantaneous. To illustrate the use of the electrometer for physiological investigations, a frog's heart was connected by non-polarisable electrodes with the instrument; each beat of the heart caused a considerable movement of the mercury column. A telephone was now connected; on pressing in the iron plate the mercury moved, and on reversing the wires the movement was seen to be in the opposite direction. On singing to the telephone each note produced a movement, but the fundamental note of the plate, as well as its octaves and fifths, had the greatest effect. On speaking the mercury oscillated continually; some letters of the alphabet had scarcely any effect, and the *w* was especially curious, producing a double movement. Reversing the wires did not alter the character or *direction* of these movements. The same effect was observed when the telephone was in the primary and the electrometer in the secondary coil of a Du Bois Reymond's induction coil. In conclusion Mr. Page showed the contractions produced in a frog's leg; on inserting under the sciatic nerve two platinium wires coupled with the binding screws of a telephone, and talking to this instrument, violent contractions ensued.

In the course of the discussion which followed, Prof. GRAHAM BELL expressed himself as highly gratified at the results of Mr. Page's experiments. He has made very many attempts to ascertain the strength of the current produced by the human voice in vain, but considers the present method will, in all probability, give some most valuable results. He was quite unable to account for the fact that the motion of the mercury took place *from* the opening, but this seems to depend on conditions not yet determined.

Mr. WILSON then exhibited for Prof. S. P. Thompson a Lantern Slide Galvanometer for showing the deflections of the needle to an audience. It consists of a coil of insulated copper wire wound on a flat bobbin, within which a needle is balanced on a horizontal axis; this needle carries a long needle of aluminium traversing a semicircular divided photographic scale, and as this is transparent, the index can be projected on to the screen. The whole is enclosed between two glass plates.

General Science Columns.

MINUTES OF PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS, SESSION 1876-77. PART III.

THREE of the papers read and discussed at the meetings of the Institution during last session appear in this volume. The volume, moreover, besides some selected papers not read at the meetings, and the usual complement of abstracts, contains several additional contributions to the discussion of the paper on the Sewage Question, published in the preceding volume, and also some memoirs of deceased members.

In the first paper, on the "Transmission of Power to Distances," Mr. Robinson treats of the various methods, such as water pressure, steam, compressed air, shafting and ropes, by which power produced at one place can be transmitted to another.

Water pressure stored up in accumulators, and distributed in pipes to hydraulic engines is extensively used in docks where the demand for power is intermittent. For instance, lock gates, capstans, and swing bridges over entrance locks only require to be united near high water, and a steam engine by working continuously and storing up the power in an accumulator (in which the water is pumped up to a height in a cast-iron cylinder, and pressed upon by a weighted ram working in the cylinder), is able to exert in a limited period a power which it would be quite unable to produce within the required time. The power, moreover, thus applied is steady, readily controlled, and capable of transmission to long distances. The loss of efficiency varies between 10 and 50 per cent., according to the machine to which it is applied. The defect of the system is, that when an hydraulic machine has occasion to exert a force considerably below its full working power, the loss of power is the same as if it had exerted its full force. Thus, if an hydraulic crane raises one ton or ten tons, the water expended is the same. The mean cost of water power is 1·26d. per foot-ton, as gathered from numerous instances.

Steam may be economically applied for transmitting power to short distances; but for long distances, owing to the variations in temperature, there is a difficulty in maintaining tight joints, the pressure is liable to fluctuations, and condensation causes loss of power.

Compressed air is frequently employed for transmission of power: it is very suitable for underground operations where in many cases steam or water would be objectionable. It has the advantage of accommodating the power to the work to be done, but the disadvantage of considerable loss of effect, amounting to at least 50 per cent. Its loss also by friction in transmission is much greater than in the case of water, owing to the far larger volume of air required to transmit the same pressure. Exhaustion of air has been tried for the same purpose, and has been utilised by the Post Office for the transmission of messages in pipes.

Shafting and ropes are only applicable for comparatively short distances.

Another method of transmission of power by the electric current, not mentioned in the paper, appears likely to go far beyond all other hitherto known methods, both as regards the distance of ready transmission, and the small loss in efficiency when the power transmitted is made to increase directly as the distance.

The second paper is on "The River Thames." Only a portion of the river, viz., between Teddington and its mouth, is dealt with by Mr. Redman. The paper furnishes a historical survey of the different changes which have occurred in this part of the river; and special reference is made to the tidal variations due to the removal of the old Westminster, Blackfriars, and London Bridges, the construction of the embankments, and the dredging operations of the Conservators. It appears that the removal of obstructions has raised the high water level, and doubtless the

embankments by reducing the reservoir area, have, to some extent, aided this result. The channel of the river has been greatly improved, and Waterloo Bridge is the only important obstruction still in existence, and in the last half century the volume of tidal water flowing in above London Bridge has increased thirty-three per cent. The extension of the embankments on the southern side of the river, is the chief improvement required; and when we consider that any works for diminishing floods in the upper portions of the river will bring down the flood waters more rapidly and in larger volumes than at present, it is evident that works for securing the low lying portions of the metropolis on the Surrey side of the river should be undertaken without delay.

The third paper is by Professor Hull "On a deep Boring for Coal at Searle, Lincolnshire." This boring, though carried down to a depth of 2,030 feet, whilst bringing to light several interesting geological facts, has not hitherto been taken low enough to decide the main question for which it was undertaken, namely, what is the easterly limit of the Yorkshire coal measures beneath the newer formations.

PROSPECTS OF THE ENGINEERING PROFESSION.

THE stagnation of all enterprise, which has now for some time been severely felt by members of the engineering profession, both civil and mechanical, cannot, in the ordinary course of events, be expected to last indefinitely. The present position of affairs has not wholly been brought about by the unsettled state of Europe generally, but may, in some measure at least, be attributed to over production and over construction during the period of the last season of prosperity. The benefits of this are now being realised by the public generally; but as soon as the means of supply had exceeded the normal rate of demand, prices fell and producers have had hard times ever since. Each season of great prosperity in any branch of industry is sure to be followed by a rush of persons to share in the gains: thus, when civil engineering is in its zenith, and the leading members of the profession have their hands full of work, the juniors all find occupation, and the numbers of engineering pupils increase, as a rule, far beyond the probable future requirements of the country; and these, when times are dull, have for the most part to fall back upon their friends, or turn their hands to some other occupation, some only temporarily, but many for good; a sufficient body, however, always remain to keep up the numbers of the profession at a strength equal to any probable future requirements for their services. The engineering works of this country during the past forty years have extended at a rapid rate, and it does not now seem possible for any great and continuous length of railway to be projected to meet any possible requirements that are not already served by existing lines, and the only probable extensions must, therefore, for the most part, consist of short and unambitious sections. But although the future field of railway engineering, so far as construction is concerned, is limited in this country, and native engineers are employed in the construction of lines in foreign countries where English engineers formerly were engaged, there still remains a vast field of undeveloped wealth in India and our numerous colonies, owing to the want both of population or of communication, and in some instances of both. When a railway is constructed, however, the work of the engineer cannot fairly be considered at an end in connection with it. The demands of increasing traffic have led to the introduction of the block system, and of continuous breaks, by the aid of which the carrying powers of a line are considerably increased; and there appears no reason why, by the introduction of further improvements, which it rests with the engineer to design and subsequently carry out, their capacities should not be still further extended beyond anything that has hitherto been effected. In shipbuilding, engineers have scarcely yet built anything in excess of the dimensions of the first floating vessel of which any records exist, and doubtless there yet remains ample scope for improvements in the design and construction of ships, and in the various machines connected with the working of them. The introduction of steel for purposes of construction will afford vessels a larger carrying power in proportion to their dimensions, and so give them the means of yielding greater commercial profits to their owners. By the improvements in boilers, in recent years, the consumption of coal on board of steamers has been greatly diminished; but it can scarcely be doubted that in course of time coal will be superseded for this purpose, and perhaps a more subtle power than steam, will take the place of the present cumbrous machinery now employed for propulsion. This is a question which deserves the attention of engineers, and for which a wide field presents itself. There seems also no reason why some sort of brake power should not be applied to vessels on the seas as a means of protection against collisions, or to enable them to bring to suddenly when required, as well as to railway trains. Whilst for commercial vessels the engineer is required to promote in every way economy and safety, for fighting-ships he has to develope fresh means of destruction and protection; vast as are the powers now employed for these purposes, it cannot be doubted—judging from the advancements in these made in recent years—that far greater powers in both directions are capable of being developed than at present exist. With the extension of commerce, and the increase in the numbers of vessels, harbours and dock accommodation must ever be required on an extended scale where they now exist, and for the convenience of new ports, as these spring into existence in parts of the world hitherto too sparsely populated to justify their indulgence in such commercial luxuries, but which in time must become necessities.

The means existing for raising sunken ships are, it must be admitted, miserably defective, and yet a vast and profitable field of labour lies open to any one who may succeed in recovering from permanent loss vessels once sunk to the bottom of the ocean. The conveyance of fresh meat from the prairie fields where cattle are only valued for their hides and hoofs, to the teeming populations of densely-packed European towns and villages, is still a question open for practical solution, dependent in a great measure upon the engineer for its accomplishment.

In mining and quarrying the scope for practical application of more economical and effective means of work is practically unlimited, and in our colonies and India untold wealth yet remains undisturbed where it has laid hidden since the development of the orbs from chaos. In India particularly, where there is already an extensive population, more than half of whom are dependent on agriculture for a living, the development of new industries and manufactures is all important, and by nothing else will this be more readily accomplished than by developing the mineral resources of the country. India is indeed a country which in the midst of wealth is poor, and nothing but British energy, guided by engineering skill, can recover it from its present position. The mechanical arts and manufactures are ever open to improvement at the hand of the engineer, and the keen competition of the present day must give the pre-eminence to those who are ever seeking for improvements and economies in the production of their manufactures, from a pin to a steam engine, by the introduction of improved appliances. Where legislative enactments are powerless to protect the country from the serious loss caused by trade strikes, the engineer is looked to for the provision of mechanical contrivances to supersede skilled labour, and many of our most remarkable labour-saving machines owe their introduction to this cause. No one will for one moment deny that ample room still remains for further inventions in this direction. The earth and the water are now the highways of the world, but science has not yet succeeded in tracking the regions of the air in a manner suitable for providing a regular system of aerial locomotion. This has been the fancy of poets and day-dream of philosophers, and it still waits upon our engineers for successful accomplishment.

At almost all times it has been the cry that nothing more remained for engineers to accomplish; like the cry of the warrior of old, there remained no more worlds for them to conquer. Yet, notwithstanding the lament, the numbers of the profession have ever been steadily on the increase, ready to meet the constant demand for their labours, in consequence of extensions in old channels, or the developement of new branches of engineering following upon the increasing requirements of man. The very birth of the engineering profession scarcely extends beyond the length of a single life, whilst within quite recent years there have been added to it the several branches connected more especially with telegraphy, sanitation, gas and water supply. As time advances, Nature appears to be opening to man's view with ever increasing rapidity her storehouse of knowledge, and although the times are, at present, doubtless wanting in that material advancement which so conspiciously distinguished the immediately preceding years, we may rest assured that it is but a pause on the general onward progress of science and labour, and judging from the past—which is usually no incorrect reflection of the future—there can be little doubt that the time is not far off when the energies of the profession will again be heavily taxed, and new enterprises and new industries will demand from the man of science, and the practical engineer, those services which have been so successfully rendered in the past.

The Radiometer and the Spheroidal State.—The following lucid exposition of the latest theories explaining the action of Crooke's radiometer, and the cause of the phenomenon known as the spheroidal state, was given by Professor Barrett in a recent lecture at the London Institution. He said, "To Mr. Stoney is unquestionably due the great honour of having been the first fully to explain the true theory of the radiometer." It was in the course of these investigations that Mr. Stoney has been quite recently led to show that the force which is so active in the high rarification (that is necessary for the effective rotation of the radiometer) is also present at ordinary atmospheric tensions. Now it is this force which forms the new explanation of the spheroidal state. In order to understand the action that occurs, it must be recollected that, according to calculation, the number of molecules of air that at ordinary pressure occupies the space of a pin's head is 1,000,000,000,000,000,000; when the radiometer globe is exhausted of these molecules of air, as far as we can do it by mechanical means, there are still some few millions remaining, and these are in constant motion. Heat makes them move more rapidly, cold more slowly. If we have two surfaces placed very near each other, one surface hot and the other cold, from the hot surface the molecules will be thrown off with greater rapidity than they reached it; and if the cold surface be near enough they will "bombard" it. Hence there will be a tendency in the hot and cold surfaces to retreat from one another, and when with one of these, as in the radiometer this is possible, it ensues. This force would obviously disappear (1) if the residual molecules could be wholly removed or so lessened in number that their action would be insensible, or (2) if the surfaces were so far apart that the augmented molecular activity had expended itself before reaching the cool surface. Applying the same kind of reasoning to the spheroidal state of liquids, we can see that it is only at relatively short distances from the metal that the interaction will occur. Professor Barrett showed by experiment that the spheroidal state could be produced with fluids from

which there could be no vapour given off, as the old theory required; and also that it could be produced in cases of very slight differences of temperature.

ELASTICITY OF PALLADIUM WIRES.—M. Gesechus finds that the co-efficient of elasticity of palladium, and of its alloys with silver and gold, diminishes during absorption of hydrogen by the wires. When the hydrogen is evolved from the wires the co-efficient returns to its original value. The strongest effect was obtained with a wire composed of 75 per cent. of palladium and 25 per cent. of silver.

OSMIUM AND IRIDIUM are the hardest metals known which can be found in any appreciable quantity. They are therefore likely to become useful for rock-drills, graving tools, philosophical instruments, balances, watches, &c. They are highly immalleable, and require the oxy-hydrogen flame to melt them. They are at present chiefly obtained from the mines of the Pacific slope, N. America.

MALLEABILITY OF GOLD.—According to the *Journal of the Franklin Institute*, Mr. Outeridge, the Master of the Mint, Philadelphia, has made the following experiments, which show how infinitessimally thin is the coating of gold necessary to gild a metallic surface. A plate of copper $\frac{1}{5000}$ of an inch thick was taken, and a strip 8 inches long by $2\frac{1}{2}$ wide, giving a surface of 20 square inches, was cut from it, polished, and then weighed by a fine chemical balance. A coating of gold sufficient to produce a fine gilding was then deposited on the strip by means of an electrotype apparatus, and the strip weighed anew. The increase of weight was found to be $\frac{1}{10}$ of a grain, thus showing that a grain of gold is capable of electro-plating 200 square inches of surface. With the same quantity of beaten gold only 75 square inches could be covered. The thickness of the electroplating was estimated at $\frac{1}{980400}$ of an inch, whereas the thickness of the beaten gold in question would be $\frac{1}{367650}$ of an inch. Seen under the microscope the thin gold skin was seen to be perfectly continuous and of a uniform pure golden tint. Detached from the copper by means of nitric acid, which dissolves the latter and leaves the gold unattacked, the skin appeared semi-transparent, and when held between the eye and the daylight it took the fine green colour of gold. Mr. Outeridge has succeeded in producing films of gold $\frac{1}{2708000}$ of an inch thick, that is 10,584 times thinner than ordinary writing paper. A film of this thickness obtained from a grain of gold would be sufficient to plate four square feet of copper plate.

MOLECULAR CONSTITUTION OF ICE.—In order to determine what are the conditions which determine the formation of non-transparent and transparent ice, M. R. Pictet freezed some water in a vase by immersing it in a chilled solution of glycerine. When the temperature of the water was kept between 0° C. and — 1·5° C., the resulting ice was quite transparent; but if the temperature was kept below — 3° C., the ice was whitish and of less specific gravity, according as the degree of cold was intensified. The opacity of the ice was found to be due from an irregular arrangement of its crystals as well as to the presence of little globules of air of less than a millimetre diameter, which were mechanically enclosed in it. These small globules cou'd be cleared away by carefully collecting them with a larger bubble.

COMPRESSED GLASS.—Messrs. Siemens of Berlin, manufacture a kind of glass compressed by means of laminoirs, which is even stronger than the tempered glass of M. Bastie. The relative resistance to breakage of the two glasses is said to be as 5 to 3 in favour of Siemens' over Bastie's. The fracture of the latter is fibrous, whereas that of the former is crystalline. The strength of a plate of compressed glass is from seven to ten times stronger than a plate of ordinary glass. Experiments made before the Polytechnic Society of Berlin have shown that whereas a plate of ordinary glass, supported at its four corners in a horizontal position, was broken by the fall of a leaden ball 120 grammes in weight from a height of three decimetres, a similar plate of compressed glass was only broken when the ball fell from a height of three metres, or ten times as high. This corresponds to an energy of blow a hundred times greater in the case of the compressed glass.

ACTION OF COMPRESSED OXYGEN.—M. Bert has recently discovered that highly compressed oxygen has the power to destroy all living animal and vegetable organisms. Fermentations which are due to the presence of living growths are entirely checked by it, whereas fermentations due to dissolved matter, like diastase, successfully resist its influence. The ripening of fruits is arrested by exposure to compressed oxygen, but the poison of the scorpion, on the other hand, is unaffected by it. Fresh vaccine matter, subjected for over a week to oxygen at a pressure of fifty atmospheres, preserved its virtue, and there is therefore good reason for believing that the active principle of vaccine lymph is not due, as has been hitherto supposed, to living cells. The virus of glanders and carbuncular blood, freed from bacteria after being treated with compressed oxygen, were found to retain their powers of poisonous inoculation, and may therefore be classed along with vaccine matter. The theory which referred these blood poisons to germs has been severely shaken by M. Bert's important investigation.

AMONGST many interesting specimens of beautiful and celebrated trees exhibited in the parks and gardens of the Paris International Exhibition—myrtles and planes from Greece, lotuses from Egypt, date palms from Arabia, cypruses from Persia, and citrons from Monaco—there will be a section of a forest giant from

the Mississippi over 60 feet in circumference. It forms part of a trunk nearly 300 feet high, which was extracted from one of the floating islands of the Father of Waters.

MR. GIFFORD has in course of construction a large captive balloon to be in operation at the Paris Exhibition. It will be over 34 metres in diameter and is intended to raise 50 persons at a time to a height of 600 metres.

SUMMER Schools for science teaching and summer scientific excursions into the country are becoming very common in America. The late Professor Agassiz was the first to inaugurate them.

AN International Exhibition under the patronage of H.R.H. King Humbert is to be held at Milan in 1879. It has been organised by a National Committee, and the municipality of the city have granted the necessary site.

PREPARATION OF SPONGY PLATINUM.—Professor Böttger in a communication to the Physical Society of Frankfort, announces that spongy platinum may be prepared by adding a small quantity of double tartrate of soda and potassa to a solution of platinum chloride, and boiling the mixture. A violent evolution of carbonic acid takes place and all the platinum is deposited in a spongy form. It is then only necessary to dry the latter on filter paper.

VISIBLE SOUND-WAVES.—Mr. Sedley Taylor recently communicated to the Royal Society a process for making sound-waves visible to the eye. A hole cut in cardboard is glazed with a film of soap dissolved in glycerine, just thick enough to produce bands of colour. This is fixed to a tuning-fork, which is put into vibration by a violin bow, and immediately a series of rings and bands corresponding to the note of the fork are displayed on the film.

FIRE IN COAL SHIPS.—A new ship, the *Sandhurst*, 1,600 tons register, recently left Glasgow with a cargo of coals for Bombay, with a new machine on board for extinguishing fire. It consists of a large pump, worked by an engine and fed by a copper pipe from the sea; and it is estimated that 10,000 gallons of water can be raised and discharged by it in an hour. The pump is so arranged that when a quantity of water has been pumped into the hold on a burning cargo, the sea-cock can be closed and the water in the hold pumped up, so as either to be returned to the sea or discharged afresh over any part of the cargo. Arrangements are also made for testing the temperature of the cargo at different points during a voyage.

COAL TAR COLOURS.—Some little time ago considerable alarm was raised in France by the report that aniline dyes were freely employed for tinting the cheaper kinds of red wine. As those salts are all more or less poisonous, the uneasiness of the public was great, and many chemists set to work to discover tests for the suspected adulterations. Several ingenious modes of detection were the result, one being a test paper called Oenokrine, which, dipped in pure red wine should be greyish blue while wet, and lead coloured on drying; if aniline colours are present it turns carmine red; if elderberry juice, green; if logwood or Brazil wood, the colour of wine dregs; if indigo, a deep blue. The reported use of aniline dyes in wine turned out to be untrue. Aniline colours are, however, employed in water colour painting, a fact which is to be regretted, since although they yield tints far more vivid and true to nature than mineral pigments, they inevitably fade in a short time.

FOUCAULT'S PENDULUM EXPERIMENT.—The pendulum experiment made in 1860 at the Pantheon by the celebrated physicist, Leon Foucault, is well known. An enormous metallic globe or gyroscope, which hung from an iron wire attached to the summit of the vault, demonstrated that the oscillation of a heavy mass freely suspended in space at the extremity of a cord without torsion, would be independent of the rotation of the earth.

The pendulum swung very slowly because of the length of the wire, and at the end of each oscillation a projecting point on the bottom of the globe furrowed a little wall of sand so as to render the displacement of the path of the globe more easily perceptible.

It is intended, we learn from *La Nature* to repeat that experiment at the Paris Universal Exposition of 1878. It will be executed with new improvements, in such a way as to impress the mass of visitors.

The pendulum weighing about 300 kilogrammes will be made to oscillate at the extremity of an iron wire from 65 to 70 metres long. Thus a special building will be required for the apparatus. Under the pendulum will be placed an immense terrestrial globe from 25 to 30 metres in diameter. This globe, resting on the ground will, along with the spectators, necessarily accompany the movement of the earth. An arrangement of large hands or pointers actuated by the pendulum will exhibit the displacement of the latter due to the earth's rotation.

The globe which will represent the earth having a considerable volume, the movement of the hands will be quite visible, and in this way the least attentive person will be able to realize the rotation of the earth upon its axis.

PHOTOGRAPHY.—The rapid development of photography as an art, the fascinating nature of its pursuit, and its growing application to solar and stellar science, have swelled the ranks of its students to quite an army of amateurs and professionals. To these, Captain Abney's "Treatise on Photography" (Longman's "Text-book of Science" series) will be welcome as combining not only the best and most reliable practical directions, but the scientific explanation of the processes. The book begins

with a history of the rise of photography, then treats of the theory of sensitive compounds, the action of light upon them, and the materials and manipulation employed in the various kinds of processes. Next, follow chapters on the various printing processes of Swan, Johnson, Willis, Woodbury, Edwards, Albert, and others,—processes by which photographs are printed off like letter-press—and lastly, there are some instructive chapters on microscopic, celestial, and spectroscopic photography. Captain Abney's book is full of very useful information and treats the subject in a truly scientific as well as a comprehensive and practical manner.

Sea Sediment.—The movement of large quantities of sediment in the sea has hitherto been commonly regarded as the result of wave motions; but another probable cause has recently been pointed out by M. Fuchs. This is the heaping up of the sea on the coast produced sometimes by the flood-tide and sometimes by the prevalence of high winds blowing in on the shore. The sea-level is frequently elevated from 10 to 30 feet in this way; and this disturbance of level originates a current from the points of great pressure, that is at the shore, to the points of lesser pressure out at sea. This current sweeping along the sea-bottom is capable of carrying, not only the fine detritus with it, but in some instances even the large boulders, and depositing them in the deeper parts.

Making Soft Alloys Sonorous.—Pewter, Britannia metal, and other such like soft metal alloys emit a dull lead-like sound on being struck; but by a process recently invented by Mr. B. Silliman, of New Haven, Con., U.S. they may be made sonorous. A bath of oil or paraffin is heated to a temperature from 5° to 5·5° below the melting point of the alloy to be treated. The exact point is determined in each case by heating the bath until a sample of the alloy suspended in it becomes ready to be stretched by a wire having a somewhat higher melting point. Small thin articles are then immersed in the bath for 15 or 30 seconds; larger articles, such as urns, are kept in a minute or more. It is essential that each article be heated uniformly, and great care is necessary in handling. The rate at which the articles may be allowed to cool is immaterial. The alloy is harder and stiffer after the process, but does not become porous. It can be soldered, plated, &c., but may not be hammered, pressed, &c., without impairing its sonorousness.

City Notes.

Old Broad Street, 28th February, 1878.

Sir James Carmichael did his best, at the meeting of the proprietors of the Submarine Telegraph Company, to smooth over the fact that there had been a decrease in the receipts of the concern. But he simply adopted the ground taken up in the report of the directors, repeating, in effect, that the falling off was due to the political and commercial state of Europe during the half-year ending December, 1877, and he did not enter into any particulars. We therefore remain in wonderment as to how it happens that while other companies have been doing better than usual in consequence of increased telegraphic traffic occasioned by the very political excitement which Sir James Carmichael deplores, the revenue of the Submarine Company has been declining. However, we do not wish to lay undue emphasis on the point. It is satisfactory to hear that the Company is likely to renew its traffic with France, and it must also be welcome intelligence to the shareholders to learn that the cables of the Company are in good working order, and that the expenditure for repairs for the last six months was less heavy than usual. We ought to have stated before that the dividend declared was *not* free of, but was less, income tax.

We suppose that the shareholders of the Mediterranean Extension Telegraph Company have no particular reason to be dissatisfied. Three per cent. is not a big dividend, but there might be no dividend; and there is nothing in the report to which exception can well be taken. But the question was very properly raised at the meeting whether the reserve fund really belonged to both the preference and the ordinary shareholders, or to the latter only, and as the reply of Mr. Ponsonby—who merely said that the fund was needed for relaying the cables required, and it was necessary that it should be kept in hand in order that the Company might retain the concession from the Italian Government—was rather beside the point, it was wisely decided by the meeting to submit the matter to the opinion of counsel. It will be interesting to learn what counsel think about it.

It is mentioned in the report of the Telegraph Construction and Maintenance Company, that during the past year the liquidation of W. T. Henley & Co., Limited, has taken place; but the Company hold a first mortgage on the estate and works and plant at North Woolwich, and the directors seem to think they have made such reserves as will cover any loss in dealing with the property. So far, that is satisfactory enough. The Company must have done a good business in 1877, for the total quantity of cable manufactured was 1,962 miles, and the total quantity laid 3,652 miles. After the dividend of fifteen per cent. is paid, there remains a balance of £61,247 to be carried forward.

It is announced by the Western and Brazilian Telegraph Company that the first annual drawing of its six debentures, will take place at the Company's offices on the 1st of March.

The directors of the West India and Panama Company have recently received a telegram stating that a new cable between Santiago de Cuba and Jamaica has been successfully laid. That section of the Company's system has thus been duplicated. We understand that the cable, which was manufactured by Messrs. Siemens Brothers, is in perfect electrical condition.

It is stated that a gentleman, whose name has for some years been before the public in connection with telegraphy, is about to receive the honour of knighthood. We have no idea how true or how false the rumour is, but should it be true, we shall be able to congratulate more than one of the telegraph companies on the distinction conferred upon their chairman. The old adage that "Nothing succeeds like success" is being constantly fulfilled, and if the gentleman in question gets a handle to his name, it will be one instance more.

THE TELEGRAPHIC JOURNAL.

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THE BELL TELEPHONE.

THE result of the legal action which has just been taken by the proprietors of the Bell telephone, or their agents, against two London instrument makers, Mr. O'Reilly and Mr. Ladd, for infringement of their patent rights, will be awaited with considerable interest by the telegraphic profession generally, and to some extent also by the public, for the telephone, by its marvellous powers and simplicity, has become a popular as well as a strictly technical instrument.

All the world has wondered at the speaking telephone of Professor Graham Bell, even for a longer period than the proverbial nine days, and all the world has admired the perseverance and the mechanical genius of its inventor. We believe we are only expressing what is in every man's mind, however, when we say that, although everybody may have wondered at the price which is charged for the instrument wherever a monopoly has been gained, no disinterested person has yet been found who admired it. The telephone is both an eminently fortunate and unfortunate invention. It is fortunate in being a marvel, and well suited for popular use. It is unfortunate in being so exceedingly simple that it can be manufactured for a few shillings. This low cost of production militates against any high royalty which may be charged for it on the grounds that it is a great and novel convenience. The proprietors of the Bell telephone have chosen to ignore its intrinsic cheapness as an instrument, and to charge a very heavy royalty under the monopolies granted them in America and England. They have looked only to the supposed advantages of the instrument, and have set a value on its prestige. The licensed price of a set of telephones, which can be made with a fair profit for ten or twelve shillings, is £25 and £35 sterling. This price includes, it is true, an electric bell alarm arrangement, but that does not cost many shillings more.

By this heavy royalty, which is generally considered to be exorbitant, the possessors of the Bell telephone monopoly have laid themselves open to competition. It is well known that several instrument makers in London and elsewhere, have been for months past retailing all, or nearly all, the separate parts of telephones, ready to be fitted together by the purchaser. It is also well known that many private individuals have made telephones for themselves; and this, notwithstanding an injunction issued by the telephone monopolists, that action would be taken against unlicensed makers, sellers, or users.

However the cases about to be tried may be decided, there can be no doubt, that the proprietors of the Bell telephone monopoly have alienated the public sympathy by their charges. So long as the telephone was surrounded by a halo of sensation, and the wealthy public were ignorant of its real cheapness, their policy may have been at least profitable for the time. Now, however, the telephonic illusion is fast disappearing, it is becoming a familiar instrument, and even its failings are being pointed out. The public are now aware of its inexpensive nature, and, however useful it may be to some people, if they purchase it at all, they will not do it with the best grace. We are much mistaken if the public instinct will countenance a charge determined by arbitrary views of the utility and reputation of an invention; irrespective of its actual cost of production. People cannot afford to pay for such indefinite entities as these entirely. Utility and repute are properly the things which give rise to the demand for an article and not the things which fix its price. Had the proprietors of the Bell telephone fixed their terms in reasonable accordance with the intrinsic value of the instrument, the demand for it would have been enormously multiplied, and we feel sure that, while rendering a real and satisfactory service to the public, they would likewise have defeated surreptitious competition, and realised more money themselves in the end.

THE TELEPHONE IN COURT.

THE telephone has at last made its appearance in Court, and the fight over it is evidently going to be a severe one. The questions that will be raised are of such interest, and the issues at stake so important, that we have thought it would be acceptable to our readers to have the cases closely watched and the results and their bearing laid before them. We therefore propose to notice, under the above heading, the proceedings that are pending, and to make such remarks upon them as may tend to render their effect clear.

The first proceeding was taken on the 8th ult., when an application was made to the Master of the Rolls, on the part of Mr. Morgan Brown, the English patentee of Bell's telephone, to whom the invention was communicated from America by Professor Bell, for an injunction restraining Mr.

O'Reilly, of the Sun Works, West Smithfield, from making and selling telephones or pieces of them. An action is pending for damages in respect of the same matter, in which, if the plaintiff is successful, an injunction to restrain future manufacture and sale would follow, as a matter of course; but the present application was substantially for the purpose of restraining such manufacture and sale *pendente lite*. If the judge were satisfied that the defendant had no real and substantial defence in a case of this sort, he would grant an injunction, as it would be obviously unfair that the plaintiff's monopoly should be damaged. In the present case, the defendant stated in affidavits that he intended, *bonâ fide*, to dispute the validity of the telephone patent on the grounds, (1st) of want of novelty, (2nd) of prior publication to a sufficient extent to enable a person of ordinary skill to construct the instrument, (3rd) that the specification, as amended by the disclaimer of Feb. 12, 1878, was a bad one. The second ground, which seems a formidable one, is founded on the fact that Professor Bell described the telephone at the Philadelphia Exhibition, and his account was published in England before the date of the plaintiff's patent, viz., Dec. 9, 1877.

The Master of the Rolls said that he was satisfied of the *bonâ fidès* of the defence, and that there were some grounds for it, and should, therefore, take the usual course of letting the matter stand over till the action was disposed of, the defendant meanwhile keeping accounts of his sales.

It appeared in the course of the hearing that a similar action is pending against Mr. Ladd.

The state of business is such in the Rolls Court that any delay which may take place before the case comes on will be due solely to the necessity of obtaining proper scientific evidence, &c., there being no such block in Sir George Jessel's court as there is in some others.

In the meantime, the general public, through the medium of the daily press, are airing some most extraordinary ideas as to what vitiates a patent. A letter from Mr. W. Chappell (for example) appeared in the *Times*, of March 9, which we commend to the notice of our readers as a very good specimen of the sort of writing now current. To such persons we would recommend a study of some elementary work on patent law. The study of it will convince them that the prior invention of a pop-gun will not, at any rate in a court of law, detract from the novelty of a Martini-Henry rifle.

THE Eastern Telegraph Company have contracted to lay a cable for the English Government between Tenedos and Scios.

LOEFFLER AND HIGGS' SIGNALLING ARRANGEMENTS FOR WORKING LONG SUBMARINE CABLES.

IN signalling over land lines or cables of considerable length, the impulses sent from one end of the line arrive at the other end in such a manner, that when they are caused to succeed each other rapidly, they are apt to produce signals running into one another, or otherwise indistinct, or to fail to produce signals, and thus the rapidity of transmission is limited. Various means are applied for remedying this defect with a view to obtain greater distinctness of signals, and to permit greater rapidity of transmitting them. In Messrs. Loeffler and Higgs' apparatus, the receiving instrument is placed by means of a bridge arrangement of suitably regulated resistances, under a definite difference of potential derived from a battery placed at the receiving station in the battery branch of the bridge arrangement, but so that the instrument does not operate for signalling, except when this difference potential is varied by an impulse caused by action at the sending station.

Fig. 1 shews one method of effecting this result:—The line or cable L is connected to the one terminal of the receiving instrument I, and also through a resistance R permanently to one pole of a battery B or other source of electricity, the other pole of which is connected to earth at E. The first-named pole of B is connected through a resistance S to the other terminal of the instrument I, which is also connected through a resistance T to earth. The resistances R, S, T, are so adjusted to each other and to the battery power, and also to the resistance of the line while the sending instrument is quiescent, as to bias the receiving instrument to such an extent that when impulses are transmitted from the sending station either the instrument will not be acted on by the beginning and ending portions of those impulses, during which portions the forces gradually increase and decrease, or that so much force will be added to these portions of the impulses that the receiving instrument will begin to be influenced nearly at the beginning and continue to be influenced nearly up to the determination of each impulse.

When applying the arrangement to a line having considerable capacity, such as a cable, a condenser or combination of condensers, as shewn at C in the diagram, fig. 2, may be connected to the branch S. For the condenser may be substituted equivalent electro-magnets.

A bridge arrangement of like kind may be employed without the separate battery B.

In the arrangement shewn in figs. 1 and 2 the instrument I and the battery B may change places; and in the arrangement, where the separate battery is not employed, the instrument I may be inserted in its place, resistances being properly adjusted.

Fig. 3 shews an arrangement for the purpose mentioned above, in which the four branches of a bridge are combined with the receiving instrument, a combination which is termed a "local bridge." In this arrangement the receiving instrument I is connected by both terminals to the branches *a*, *b*, *c*, *d*, which are equal or so proportioned to one another that the instrument is not affected by any current transmitted by the cable or line L when a condenser

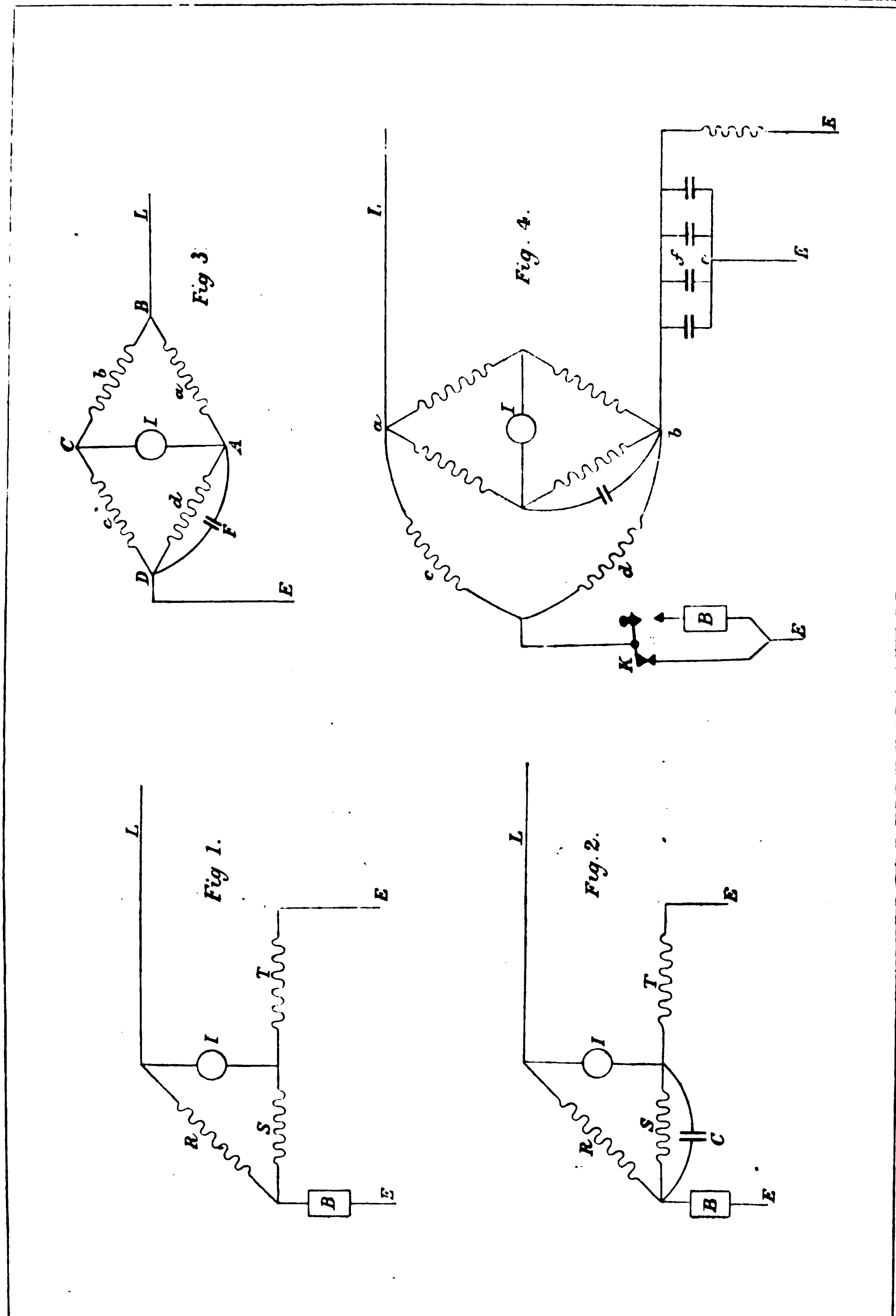


Fig 3
L
B
b
a
C
I
A
c
d
F
D
E
Fig. 4.
L
E
f
c
E
a
I
b
c
d
B
K
E
Fig 1.
L
I
T
E
R
S
B
E
Fig. 2.
L
I
T
E
R
S
C
B
E

F is not connected to one of the branches a, b, c, or d. But when such a condenser as F is connected to one of the four branches the receiving instrument is actuated only by the charge and discharge of the condenser. Under certain conditions, by avoiding exact balance of this bridge system, permanent currents may be made to aid the condenser in actuating the receiving instrument. By proper adjustment of the capacity of the condenser to that of the line, so that the condenser charge affects the receiving instrument for a less time than the charge or discharge of the cable would affect it, increased speed is obtained. As the receiving instrument is not directly included in the line circuit its coil may be wound so as to give increased delicacy, as for example, by employing a greater number of convolutions than it would be possible to use in direct circuit with the line without great sacrifice of speed. For the condenser F and resistance d, shewn in fig. 4, an electro-magnet may be substituted.

In the arrangements above described additional condensers, or their equivalents, may be applied in the several branches of the bridge. Instead of employing a bridge arrangement, a differentially wound receiving instrument may be used, placing a condenser in connection therewith, so as to cause the instrument to be affected not by the line current but only by the condenser.

A bridge arrangement somewhat similar to that described above has been employed for duplex telegraphing, but in that case it is applied for the purpose of preventing the receiving instrument from acting under influence of signalling currents transmitted from the receiving end of the line, and consequently the resistances and connections are arranged to maintain different electrical conditions.

For duplex telegraphing the "local bridge" combined with known arrangements for duplex working is employed. One such combined arrangement is shown by fig. 4. In this case the "local bridge" enclosing the instrument I is connected at a and b to the branches c and d of a duplexing bridge, and also at a to the line wire L, and at b to an artificial line e, f, which may consist of condensers, as shown in the figure. The junction of c and d is connected to the operating key K commanding the poles of the battery B. In this arrangement the receiving instrument is acted on as described with reference to fig. 3 when currents are transmitted to it from the line, but it is not affected by currents transmitted from the key K to the line.

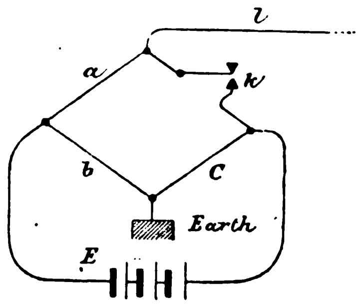
In the bridge arrangements described, although for the sake of simplicity only one battery or other known appliance is shown in the diagram, it is obvious that several such batteries or appliances might be employed.

A SINGLE CONTACT DOUBLE CURRENT KEY.

IN every form of double current key hitherto in use, from two to four contacts have been employed in addition to the switch contacts which cut off the battery and put the line wire through the receiving instrument to earth. Where four contacts are employed, as in the ordinary double current key the play of the lever is necessarily considerable, otherwise false signals are liable to be made. Again, in the latter form of key, the several currents must be of equal strength; and in the submarine keys, where not less than two contacts are employed, it is usual to have two batteries, one for sending a current in one direction and the other for giving a reversal. In the following arrangement, only one contact and one battery is employed for sending reversed currents; and, moreover, the relative strengths of these currents can be adjusted to a great nicety. The figure shows the method by which the result is arrived at. a, b, and c are three resistances forming the arms of a Wheatstone bridge, E is a battery, and l, the line wire. The fourth arm of the bridge is formed by a single contact key, k. As is well known, if this fourth arm were of such a resistance x, that

$$x = \frac{a\,c}{b}$$

then no current would pass out to line; but if x were larger than this value, then a current would pass to line in one direction, and if x were smaller than $\frac{a\,c}{b}$ then a current would pass in the opposite direction. It is clear if x were made either 0 or ∞ by making



this fourth branch a key, and depressing or leaving it up, that reversed currents of maximum strength could be sent out to line, and by adjusting the resistances a, b and c, the relative values of these currents could be altered at pleasure.

A peculiarity in the arrangement consists in the fact that the reversal takes place without any break, and it might therefore prove of service as a "pole changer" in the quadruplex telegraph system, and, indeed, in any telegraphic apparatus where a multiplicity of contacts might be objectionable, and where an instantaneous reversal is required.

H. R. K.

THE TELEPHONE DESK.

THIS very convenient arrangement, of which we give an illustration, is well adapted for private offices and will no doubt come into extensive use.

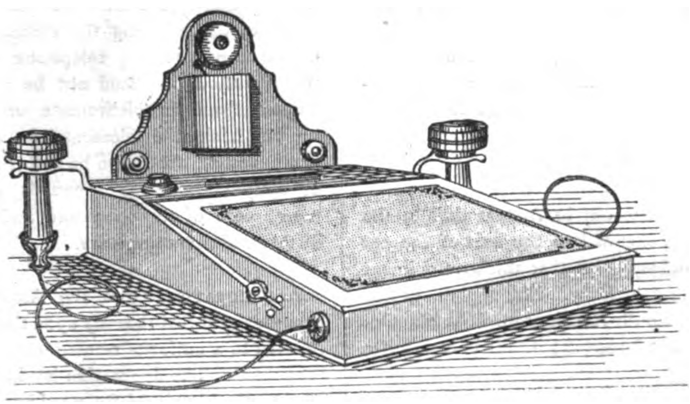
It consists of an ordinary office desk provided with a trembling bell on a board at the back. A call-button is placed at the corner of the desk, and on each side are brass brackets in which two telephones normally rest.

One of the brackets is connected to the line wire

and is hinged and plays between two contact points. Of these latter, one is in circuit with the telephones and the other with the bell.

The weight of the telephone in the hinged bracket presses the latter down on the bell contact point, so that, normally, the bell is in circuit with the line.

attention of either station has been called on its bells by pressing the call button at the other station, the former replies by pressing his own button to notify that he has observed the call, and then both stations taking their respective telephones out of their brackets, the hinged brackets rise slightly under the influence of springs and put the telephones in



The desks at both ends of the line have similar connections, and are provided with batteries which ring the bells when the call buttons are pressed.

In working the arrangement then, when the circuit; the correspondence is then carried on. On the completion of the communications the telephones are returned to their brackets, and the bells become again put in circuit.

Notes.

There was a very full assembly at the meeting of the Society of Telegraph Engineers on Wednesday, the 27th Feb., owing to the announcement that Mr. W. H. Preece would exhibit the phonograph. Electricians were curious to see this wonderful instrument, and to hear for themselves whether or not its actual performances justified its astonishing repute. Three different phonographs were tried, but precedence was of course given to one sent over from America by the inventor, Mr. Edison. There was absolute silence in the hall, followed by a burst of surprise and delighted applause, when the little piece of mechanism on the table plainly uttered, with a comical assurance all its own, "The phonograph presents his compliments to the audience." It then recited poetry, sang songs, coughed and crowed, laughed heartily, and gave vent to a succession of jubilant hurrahs. One after another, this amusing parody of human speech truthfully expressed a variety of emotions, enthusiasm, merriment, patriotism, and even pathos, and proved itself capable of reproducing, at least to a certain extent, individual tone and manner. In its present form, however, it has a characteristic individuality of its own which disguises the voices of the speakers which it mimics. But this only heightens the illusion of its own personality. The phonograph, above all other instruments, fills us with that strange sense of the individual life of a machine. Orderly motion is at the root of this impression, and speech added completes the effect. It is when we see an instrument like this in operation that we get a glimpse of the full glory of invention; and we cannot but admire the audacity of genius which has led Mr. Edison with means so simple to realize such marvellous results. At the conclusion of the meeting the phonograph (after having been charged by Mr. Spagnoletti) gave the National Anthem with quite a stirring effect; and it was as much a compliment to Mr. Edison, and a tribute to the powers of the instrument, as a mark of loyalty to the Queen, that the audience the while remained standing.

Mr. Edison has devised a means of driving sewing machines by a vibrating tuning-fork. The fork is maintained in vibration by a pair of electro-magnets, actuated by a battery whose circuit is interrupted timeously by the arms of the fork. Between the arms of the fork there is a "ratchet" wheel, and each arm carries a "cleet" which works into the wheel—one on the top, the other underneath. When the fork is started into vibration the wheel is rotated, and a grooved pulley, carried by the same axle as the wheel, communicates the motion of the wheel to the parts of the sewing machine.

TELEPHONIANA.—The telephone has been adopted into the outpost system of the Russian army. The line employed is a light cheap cable, which can be laid over any kind of ground by one man. It is in lengths of from 400 to 500 metres, this being the average distance between pickets and supports, and consists of two insulated copper wires. Each length weighs from 8 to 10 lbs., and costs about £3. The winding apparatus, together with two telephones, costs £1 more—total for each length, £4. Bad weather is not found to interfere with the working of the telephones; but noise, of course, does, and it becomes necessary to cover the head with the hood of a great coat to exclude extraneous sounds.

MR. W. ACKROYD points out in *Nature* that in the human ear the drum is inclined to the axis of the ear at an angle of 46°, and suggests that this arrangement should be imitated in telephony. Mr. Newth, of the Chemical Laboratory, South Kensington, finds his telephone to work best when he speaks into it in a slanting direction.

IN order to compare the intensity of sounds as given out by the telephone with their original intensity, M. Demoget, of Nantes, has experimented with two Bell telephones in an open field. He held one of these to his ear, whilst his son at a distance kept repeating the same syllable with the same intensity of voice into the second instrument. He compared in this way the sound heard from the telephone with that heard from the speaker, and calculated their relative intensities from the relative distances of their sources from his ear. When the telephone was held about 5 centimetres from his ear, and the distance of the speaker was 90 metres, the direct and telephonic sounds were of equal intensity, and the ratio of the intensities at the source was therefore as 25 to 81,000,000; in other words, the sound transmitted by the telephone was only about $\frac{1}{3000000}$ of the sound emitted. Owing to the influence of the ground, however, the stations could not be considered as points in free space, and M. Demoget therefore alters this ratio to $\frac{1}{1800000}$. From the fact that the intensities of two sounds are proportional to the square of the amplitude of the vibrations, it follows that the vibrations of the two plates of the telephones were directly proportional to the distances, that is to say as 5 is to 9,000 (centimetres), and that the vibrations of the receiving telephone are 1,800 times smaller than those of the transmitting telephone. They are, therefore, comparable to molecular vibrations. M. Demoget, without wishing to diminish in anything the merit of Bell's invention, concludes from these results that the telephone as a machine leaves much to be desired since it can only transmit $\frac{1}{1800}$ of the original work, and remarks that its results, so unexpected, are due rather to the perfection of the organ of hearing than to the perfection of the instrument.

MM. POLLARD AND GARNIER continue their telephonic experiments with a transmitter on Edison's carbon-contact principle, and a Bell telephone connected to the line through an induction coil as a receiver. Such is their success that Count du Moncel is of opinion that this union of the telephones of Bell and Edison will solve the problem of telephony on a practical scale. Only a small induction bobbin is necessary; it has the effect of accentuating the current, so to speak, and it causes the receiving telephone to articulate sounds which without it would not be produced. When the current from six bichromate of potash elements or twelve Léclanché elements is employed with this arrangement, words can be heard at a distance of fifty or sixty centimetres (upwards of 1½ ft.) from the mouthpiece of the telephone, and musical sounds at a distance of several metres.

A DEPUTATION from the Associated Chambers of Commerce waited recently upon the Postmaster-General relative to a uniform rate of charge for all European telegrams. The deputation having been introduced by Mr. S. S. Lloyd, M.P., president of the Associated Chambers of Commerce, a memorial to the following effect was presented to Lord J. Manners:—"That commerce and industry were very much crippled by not having a uniform rate of telegraphing, in the same way as had been adopted with respect to the penny postage. The surcharge on provincial foreign telegrams was a subject much to be deprecated. It was of great importance that her Majesty's Government should enter into arrangements with the contracting powers, by which the cost for inland messages should be made equal to all others. And the association feel persuaded that a uniform rate of 2s. 6d. per twenty words should be adopted." The Postmaster-General replied that he agreed with the spirit of the memorial generally, and thought that the same rates should be charged in the provinces as obtained in London for all foreign telegrams. An assimilation of prices would be proposed at the forthcoming international conference in London, but at present he could not enter into full particulars. The Government was, however, prepared to see a "word" rate introduced, which would, no doubt, have the effect of lowering the prices of telegrams. Although telegrams were cheaper abroad than in England, still foreign governments had not paid so much for their telegraphs as we had, and he did not see how the charge could be reduced in this country. Parliament was very jealous of allowing more money for the telegraph service; but he would see what could be done to meet the views of the deputation.

A NEW American society called the Electrical Society of the Ohio Valley has just been founded at Cincinnatti, and one of its first acts has been to telegraph President Hayes, recommending the appointment of Mr. C. H. Haskins, superintendent of the N. W. Telegraph Company of Milwaukee, as United States' Commissioner

in the Department of Electrical Science to the Paris Exposition.

A CONSIDERABLE quantity of submarine cable has been purchased by the Treasury, and is now stored at Woolwich.

ACTION has been taken by the proprietors of the Bell Telephone against Mr. O'Reilly and Mr. Ladd, instrument makers, for infringement of the telephone patent, which is taken out in the name of Mr. Morgan Brown. Mr. Asten, Q.C. appeared before the Master of the Rolls, in the Chancery Division of the High Court of Justice, and applied for an injunction refraining the defendants from the alleged infringement. The infringement was denied by Mr. Davey, Q.C., and Mr. Cozens Hardy, who represented the defendants. Both cases were allowed to stand over, Mr. O'Reilly's for a week, and Mr. Ladd's for a fortnight, on condition that each of these gentlemen should keep an account.

THE "Bell Telephone Company" in America is about to meet with rivalry in the "American Speaking Telephone" Company, which has been organised by a number of the officers of the Western Union and Gold and Stock Telegraph Companies. The telephone it is proposed to employ is that of Professor Amos E. Dolbear of Tuft's College, the author of the pamphlet on *The Telephone* which has been selling of late in London. Dolbear's telephone has been improved by Mr. Phelps of the Western Union manufactory, having been fitted with a second diaphragm which increases the volume of sound. As improved by Phelps, Dolbear's telephone has been patented, and goes by the name of the Phelps' Duplex Telephone. The Bell Telephone Company it is said, claim this to be an infringement of their patent, and have issued a notice to the effect that the only telephone protected in the United States is that of Professor Bell, and that persons infringing this patent are liable to prosecution for damages. No telephones have been put up as yet by the new company, and some interest is manifested in American electrical circles at the course of procedure the Bell Telephone Company will follow when they are in operation. The rental to be charged by the new company is the same as that established by the Bell Telephone Company, namely, 50 dollars (£10) per annum for a double set of telephones. This charge is considered "somewhat exorbitant" in America.

SOCIETY OF TELEGRAPH ENGINEERS.—Mr. James Allen, telegraph engineer, Buenos Ayres, and superintendent to the Great Southern, Northern, Ensenada and Campana Railways, has accepted the office of hon. secretary and treasurer to this society in the River Plate, in lieu of Mr. Carlos Burton.

A LARGE number of prairie hens are annually killed by striking against the telegraph lines in the Far West.

AUSTRALIAN TELEGRAPHY.—A fine new postal and telegraph office was opened last December at Bathurst, Australia. On the opening day, the Postmaster-General gave the following interesting particulars regarding the Australian Electric Telegraph Department. In 1866, the number of stations was 63; in 1876, 154. In 1866, the extent of wire in operation was 3,346 miles; in 1876, 8,472. During 1866, the number of messages transmitted was 143,523; during 1876, 854,204. For 1866, the total revenue for the department was £30,698 7s. 7d., and the expenditure, exclusive of interest on the cost of construction of lines, £24,506 18s. 9d.; while for 1876, the revenue was £59,384 11s. 6d., and the corresponding expenditure was £69,229 4s. 9d. This increase has been largely due to extension of office hours, and reduction of tariff. The principal country offices are now kept open till 10 p.m.; and a message from Bathurst to Melbourne, which in 1866 cost 6s., now costs only 2s.

IT is proposed to establish two powerful electric lights on the towers of Notre Dame during the Paris Exhibition season. They will operate once or twice a week, and will be turned upon the City, so as to illuminate the principal edifices. The first trials will be made towards the end of April.

APPLICATION OF THE TELEGRAPH TO FLOOD ALARMS.—If the electric telegraph has been advantageously utilised in warning maritime ports of the approach of storms, it may be rendered still more useful in notifying to districts subject to river floods the abnormal rises which take place on the higher reaches, and which are capable of causing incalculable damage if the necessary precautions against them are not taken. We have proof of it in the last great inundations which occurred.

The government (French) having been forewarned in October, 1857, that at Blois, Tours and Angers, a rising of the Loire was expected, which might lead to great disasters, seeing that despatches from the Haut-Allier and the Haut-Loire announced an abnormal elevation of the level of these two rivers, the minister of war sent to Tours and Blois two companies of engineers and two battalions of infantry to direct the works in case of danger, and to maintain order. They despatched at the same time several thousand entrenching tools to increase the resources of the localities. The troops and implements arrived at their destination a considerable time before the flood wave, which appeared at the precise time predicted four days before by the telegraphic despatches. The presence of these auxiliaries was attended by the happiest results.

During these latter years, this service has been well organised in France, thanks to the efforts of two distinguished engineers, M. de Mardigny, engineer-in-chief of the department of the Meuse, and M. Poincaré, their engineer of navigation in the same department, who took the initiative in the matter. To-day, tracts

menaced by inundations can be alarmed a sufficient time beforehand to enable them to take the first and most urgent measures of safety. The Hydrometric Commission of the Rhône and of the Saône, presided over by M. Fournet, has arrived at some remarkable results upon this important and interesting question. We will also cite the labours of M. Belgrand upon the water courses of the north and north-west of France. The inundation of the Seine in 1876, has revealed the services rendered by that engineer. We will instance further the case of the Observatory of the *pic du midi*, which announced several days in advance the frightful floods which ravaged all the basin of the Garonne in 1875.—*Count du Moncel.*

INSULATING GLASS.—A glass jar of a Thomson's Quadrant Electrometer, possessing a high power of insulation, has been analysed by Herr F. Primke (*Dingl. polyt.* I., Vol. 125, p. 174) with the following result:—

SiO_2	K_2O	Na_2O	PbO	CaO	MgO	Fe_2O_3	MnO
58·450	9·236	3·745	28·019	0·064	0·054	0·474=100·042	

Impurities neglected, the composition is as follows:—

SiO_2	K_2O	Na_2O	PbO
58·77	9·28	3·77	28·18=100

PHOTO-ELECTRICITY OF FLUORSPAR.—Herr. W. Hankel (*Ann. de Phys. und Chem.*, Vol. II., 66-83) finding that some crystals of fluorspar from Weardale, Durham, exhibited strong fluorescence and phosphoresence, judged that they might also exhibit electrification on exposure to light. He therefore exposed a crystal to light and found that not only was the crystal electrified but the electrification was much stronger than that exhibited when the same crystal was heated. One experiment was as follows:—A blue violet crystal from Weardale was immersed in copper filings with one face exposed, and kept for some time at a temperature of 95° C. Shortly after it began to cool the face showed an electrification or potential indicated by + 2 divisions on the electrometer employed. On exposing the same crystal to sunshine, the electrification was indicated by — 23 divisions; and on exposing it for two hours to diffused daylight, the electrification was — 1·7 divisions. When, on the other hand, the crystal was exposed to the rays of the sun concentrated upon it by a large lens, it lost its photo-electrical property and did not regain it. Similar results were obtained from three other dark green Weardale crystals. From experiments with coloured glass Herr Hankel concludes that the photo-electricity is due to the so-called chemical rays.

MR. E. GRAVES has been officially appointed engineer-in-chief, and Mr. W. H. Preece, Assistant engineer and electrician, to the Post Office.

DURABILITY OF CABLES.—Mr. Thomas Fuller, managing director of the Black Sea Telegraph Company, writes to us stating that Mons. Lacoine has reported that during the recent repairs of the Constantinople to Odessa cable, the Constantinople to Varna cable of 1854 was hooked, and the portion taken out found to be in perfect condition after twenty-four years' immersion.

WE hear that Messrs. M. Theiler & Sons are making a phonograph which may be used either as a talking machine or as a logograph. The record is in both cases produced upon a ribbon of paper passing between rollers instead of upon a sheet of tinfoil mounted on a grooved cylinder. By this means, the trouble of fixing the sheet of tin-foil and of screwing back the cylinder is entirely avoided. This machine is said to be always ready to talk and to be talked to.

Patents.

719. "Improvements in and appertaining to galvanic cells or batteries."—W. S. WILSON, Feb. 21.

759. "An improvement in the manufacture of telegraph cables."—F. LAMBERT, Feb. 23.

767. "An improved method of covering telegraph wires, wires for electrodes, electro-magnets, galvanoscopes, and others, and also webs of fibrous materials and metals."—N. CONRADI (communicated by R. Wiebe), Feb. 25.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1387. "Electric apparatus for actuating railway brakes."—F. F. A. ACHARD, Paris. Dated April 9, 1877. 6d. This consists in blocking the wheels instantaneously by the employment of electricity, steam, compressed air, or vacuo. In the different arrangements described, the brake lever is lifted by one or more chains, which are wound on a shaft or sleeve receiving a rotary movement from the axle of the vehicle, through the intermediate action of an engaging apparatus. The parts which serve to put the brake in action serve also to effect at the proper moment the engagement of an axle which turns continuously with the shaft or sleeve of the chains. The brake is actuated by electricity, in the manner described in former patents of the author, (1268 of 1862, 3006 of 1864, and 2350 of 1873), and improved so as to stop a train in less than a second if necessary, whatever be the speed of the train and gradient of the way.

1475. "Printing telegraph instruments."—F. H. W. HIGGINS. Dated April 14, 1877. 6d. This consists in a design for a printing telegraph instrument capable of being worked on a single wire without the aid of clockwork for driving the type-wheel. Either one or two type-wheels fixed to a common axis, and driven by a propelment so constructed as to prevent the momentum of the type-wheels carrying them beyond the desired point, are employed as printers. To control the type-wheels there are two pallets, carried by a rocking lever, which act alternately on the top and bottom of a ratchet-wheel on the axis of the type-wheel, and there are pin-stops for the pallets to come against at the end of their forward movement. The armature

which carries the pallets is composed of iron and brass, and is magnetised from a large fixed permanent magnet, through the arbor of which it forms a part. The transmitter sends alternate currents, which by means of electro-magnets effect the printing.

1486. "Galvanic batteries."—E. BLAKEY. Dated April 16, 1877. 2d. This describes a form of Léclanché cell in which the graphite pole takes the form of a partition. *(Not proceeded with.)*

1572. "Gilding."—A. J. DUPUIS and G. O. SCHULZ. Dated April 23, 1877. 2d. This consists in gilding picture frames by coating them first with black lead and electro-gilding them. *(Provisional protection not allowed.)*

1583. "Apparatus for generating electricity."—C. CLAMOND. Dated April 23, 1877. 6d. This consists in improvements in Clamond's thermo-pile, which have been fully described in the TELEGRAPHIC JOURNAL for Feb. 1st.

1598. "Watchman's electric tell-tale and fire-alarm."—W. J. HANCOCK and S. M. YEATES. Dated April 24, 1877. 6d. This consists in a means of testing the faithfulness of a watchman at his post. A pin, wheel, or cam is fixed on the minute-arbor of an ordinary clock; this lifts an arm carrying two contact springs on to a stop fixed in the armature of an electro-magnet, which holds the said arm in position until contact is made by the person in charge. If left in this position longer than the proper time, the cam in revolving makes contact with one of the springs, and shews that the person in charge is defaulting or absent from his post. If the watchman be attending he makes permanent contact, and the cam comes into contact with the other spring, thereby causing an alarm bell to sound and notifying the fact. The patent also provides for signals being sent from a number of stations or compartments to a central one, by means of a small shaft fitted with a corresponding number of cams and contact springs; an indicator being fixed in circuit with each.

1599. "Electric telegraph apparatus." G. T. PATERSON. Dated April 24, 1877. 2d. This is intended to produce a perfect block system of signalling, so that when a signal indicating the passage of a train has been forwarded to the next station on the line, and the sending apparatus has been blocked, no other signal can be forwarded until the first signal has been acknowledged from the next station. This is effected by attaching to the sending station signalling instrument a spring bolt, which is pushed under the "tapper" when the signal has been made so as to prevent the "tapper" descending, unless the return signal is made. *(Not proceeded with.)*

1602. "Telegraphic discs or signalling apparatus."—URSIN JUSTON, Paris, dated April 25, 1877. 1s. 2d. This consists in a method of controlling a telegraph or signal disc by means of electricity so that the disc is shown or not from a signal post. The disc is retained in its out-of-sight position by mechanism which can be actuated by electro-magnetism, so as to free the disc, upon which the latter mounts to the top of the post, by a counterpoise, into its visible position. The disc is a square plate of sheet iron, and carries a ring on which the retaining apparatus takes hold. The current by actuating the electro-magnet of the retaining apparatus frees this ring, and allows the disc to rise into view. The disc is lowered again and set in its retained position by an attendant. This system is designed for application to railways, in order to prevent collisions of trains. A disc should be placed at each curve of the line so that the engine-driver can see from one disc to the next. The disc is controlled by the departure and arrival stations. A line wire is necessary to put all the discs in simultaneous motion, whatever be the distance, so that all the station-masters may always know the position of the trains which are travelling.

1640. "Chemical telegraphs."—C. A. RANDALL and T. M. FOOTE, New York, U.S., dated April 26, 1877. 10d. This consists in a method of transmitting signals electro-chemically over a single wire, and printing the message in Roman letters, a letter being obtained at each electric impulse. This is done by having two type-wheels, one at the sending and one at the receiving station, turning isochronously. A strip of chemically prepared paper passes between the marking style or pen, and the type-wheel of the receiver, so that the current from the sending station in passing from the style to the type-wheel decomposes the chemical preparation at the points where the type touches the paper, and thereby produces an exact fac-simile of the letter.

TRAFFIC RECEIPTS.

Name of Co., with amount of capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £90,000.	Cuba Sub. Co. £16,000.	Direct Spanish Co. £13,000.	Direct U.S. Co. £65,000.	Eastern Co. £369,700.	Eastern Ex. Co. £199,750.	Gt. Northern Co. £125,000.	Indo-Euro. Co. £17,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £69,910.	West India Co. £88,320.
	£	£	£	£	£	£	£	£	£	£	£	£	£
February, 1878...	43,470	9,671	*2,800	814	10,010	41,831	20,716	12,725	... ...	9,257	1,425	7,721	*5,034
February, 1877 ...	32,290	11,725	2,214	784	15,520	35,050	19,645	12,800	... ...	8,624	2,980	11,343	3,870
†Total Inc. 1878	23,340	... ...	1,275	23	... ...	5,732	... ...	508	... ...	586	... ...	... ...	2,306
†Total Dec., 1878	... ...	1,754	... ...	... ...	5,310	... ...	171	... ...	... ...	... ...	2,263	3,545	... ...

* Estimated. † Compared with same period 1877.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness.)

Correspondence.

ON THE RESULTANT FAULT.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—Some years ago it was proved that in taking the loop-earth-test the same result would be obtained, in any particular case, if all the leakages were replaced by a single leakage having a resistance equal to the true insulation resistance, and existing at the centre of gravity of the conductivities of all the leakages. Recently Professors Ayrton and Perry have investigated in their paper on "The resultant fault in the conduction, insulation, and circuit tests," whether the same substitution could be effected in the three tests just mentioned, and they found that the error so made in the conduction test was very small, in the insulation test that it was a little larger, and in the circuit test (or test of the line put to earth through the receiving instrument) that it was still larger, being, however, in all three cases very small, provided the ratio of the true wire resistance of the whole line to the square root of the insulation resistance of a length of line having unit wire resistance was considerable. The method of reasoning they employed in obtaining these results was applicable in all cases when the insulation resistance at any point of the line was such a function, $f(\rho)$, of the wire resistance, l, up to that point that the differential equation

$$f(\rho)\,\frac{d^2v}{dl^2} = v$$

could be integrated, so that v, the potential of that point, could be found.

Starting with the assumption that this substitution of a resultant fault could be legitimately made in the conduction insulation and circuit tests when the insulation of the line was uniform, Mr. Schwendler, some time ago, developed formulæ for ascertaining "the corrected or true conduction and insulation resistances," and also a formula for calculating the resistance of the distant receiving instrument, the result obtained by which, being compared with the known resistance, serves as a check in deciding whether or not the insulation of the line is uniform, *i.e.*, in fact, whether or not Mr. Schwendler's formulæ for the corrected conduction and insulation resistances can or cannot be used, and also which gives an indication of the kind, but *not* of the magnitude, of the error made by using them when the resultant fault is not in the electrical centre of the line. But I am not aware that any simple formulæ have been published for determining the true wire and insulation resistances, independently of the position of the resultant fault. Now Professors Ayrton and Perry have suggested to me that M. Blavier's well-known formulæ would enable us to do this if the true wire resistance of the line, which, in M. Blavier's equations, is always assumed to be previously known, were regarded as an unknown quantity, and the distance up to the fault, which is also unknown, were eliminated by combining with the usual conduction and insulation tests one other—the circuit test—or test when the receiving instrument, of known resistance, is inserted in the line at the distant station. Consequently I have worked out the following equations, which are so simple in their application, that attention need only be drawn to them to show their practical utility.

Let w be the true wire, and u the true insulation resistance of a line; x the wire resistance up to the resultant fault; c, s, i, the resistances obtained when taking the conduction circuit and insulation tests, and r, the known resistance of the receiving instrument at the distant station: then it may be easily proved that

$$w = \frac{r(i-s) + i(s-c)}{s-c} - 2\sqrt{\frac{r(i-c)(i-s)}{s-c}}$$

$$u = \sqrt{\frac{r(i-c)(i-s)}{s-c}}$$

$$x = i - \sqrt{\frac{r(i-c)(i-s)}{s-c}}$$

For by M. Blavier's equations we have, if y is the wire resistance from the resultant fault up to the distant station,

$$x = c\sqrt{(i-c)(w-c)}$$

$$y = (w-c) + \sqrt{(i-c)(w-c)}$$

$$u = (i-c) + \sqrt{(i-c)(w-c)}$$

(*See* Clark and Sabine's Electrical Tables, *page* 47.)

Also in a similar way it may be shown that

$$x = s - \sqrt{(i-s)(w+r-c)}$$

and from these four equations y can be eliminated, and w, u, and x found, obtaining the results given above.

I beg to remain, Sir,
Very truly yours,
T. IWATA,
Telegraph Engineering Student.

The Physical Laboratory,
The Imperial College of Engineering,
Tokio, Japan.

To the Editor of THE TELEGRAPHIC JOURNAL.

MY DEAR SIR,—It may be interesting to inform the readers of your valuable journal that a very satisfactory telephonic conversation has taken place between "Persia and Russia." The officiating gentlemen were Mr. C. Taplin, of Cardiff, now in the Indo-European Telegraph Company's service, at Tabreez, and Mr. F. E. Gibbins, of the same Company, at Tiflis. About midnight, when all was quiet and traffic ceased, a telephone was fixed at each end of the wire, and a conversation, besides some vocal music, took place at the very long distance of 390 miles. The weather was very fine throughout the line, with a sharp frost after a fall of snow at Tabreez.

Owing to the commencement of despatches on the Russian wire (which line runs parallel to that of the Indo) in Armenia, induction put a stop to the wonderful conversation, so the gentlemen wound up by exchanging the National Anthem of old England.

The telephone used at Tiflis was made by Messrs. Siemens and Halske, and that at Tabreez (the first in the country) by Mr. C. Taplin himself, to whom great credit is due for making so delicate and sensitive an apparatus, whilst so badly provided with materials, &c.

Trusting to your kindness for the insertion of the above in your journal,

I remain, dear Sir,
Yours very truly,
HILDND. F. STEVENS.

Persia, Tabreez,
February 20th, 1878.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—Your journal of the 15th February, 1878, contained the translation of a paragraph from *Count du Moncel*, relative to the application of the telegraph to the herring fishery in Norway.

The substance of this quotation was printed in *Nature* of 28th February, but without acknowledgment either of copying it from the TELEGRAPHIC JOURNAL, or from *Count du Moncel*; and, quoting from *Nature*, I observe, *The Times*, on March 1st, 1878, reprints the same thing; and, like *Nature*, commences thus, "A novel use of the telegraph has lately been adopted by the Norwegian Government."

It would therefore appear that it is not generally known that the paragraph, of which you gave the translation, occurs in Count du Moncel's "Traité théorique et pratique du Telégraphie Electrique," which was printed at Paris in 1864, and that this application of the telegraph is by no means so new a thing that it may be said to have been "lately adopted by the Nowegian Government."

If these "200 kilometres" of cable are still in working order, having been repaired or renewed as required from time to time, according to the ordinary necessities of submarine cables, no doubt they render as good service now, as they did when first established, *at least fourteen years ago*.

How many years are to be added to these fourteen I am unable to say.

JAS. GRAVES.

Valentia, March 9th, 1878.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—The article alluded to as accrediting Mr. Paul with the gelatine transfer negative process and alluded to by Messrs. Wratten and Wainwright in your issue for February 15th, was perfectly well known to me, and as far as priority of publication goes Mr. Paul certainly has the lead. However, I do not see how the case I alluded to is altered. Why did not Messrs. W. & W., who evidently knew that the process was anothers, not mention the fact, their article distinctly conveying the impression that the process was part of *their* new system of Photography.

What the 11th commandment is I do not know, therefore I am unaware of the principle on which I should drop my claims, which are as follows:

On the day that the article was published in the British Journal, I was crossing Mont Cenis on my return from Italy with some 40 or 50 transferred negatives, lying between the leaves of a book in my portmanteau. These were taken and transferred at different times between the latter part of January and the beginning of May, on the fifth day of which latter month the article appeared. Such is my claim, which can easily be substantiated by gentlemen residing in Naples.

Yours obediently,
WALTER B. WOODBURY.

South Norwood,
March 7th, 1878.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

(*Continued from page* 101.)

ACROSS the Hudson and its branch, the East River, at New York, are several cables, made up of seven conductors, and weighing about eight tons to the mile. As they lie right across the anchorage grounds they are continually being fouled by ships' anchors, in some cases, five or six times a day. The Western Union Co., therefore, keep a tug with steam up always ready to run out and assist to clear or repair the cables.

Some very smart work is sometimes done in this way. Messrs. Preece and Fischer were present on one occasion when a mile and a quarter of cable in fourteen fathoms was picked up in forty minutes. It was then repaired and carried to another part of the river, where it was laid out in *six* minutes.

The land lines are as sound and good as any of our own. Poles average twenty five feet high, and six inches diameter at top, and are mostly of red or white cedar. They cost from half a dollar to one dollar each, and last twelve to twenty years. In many places chestnut, which in America grows very straight, is employed; cypress and other woods elsewhere, according to locality. In England, our poles if unpreserved, last only seven or eight years, but the climate of America is so much drier that wood lasts longer. It is also cheaper, and therefore no preserving processes are employed, nor are iron poles used. Arms are generally of white pine; for two wires their length is three feet, four wires five feet six inches, six wires seven feet six inches. The wire is sometimes ungalvanised, but the use of ungalvanised wire is dying out, and in future, most of the wire will be galvanised. Numbers six, eight, and nine, are the gauges in use, number six being principally used for long distances.

To America is due the credit of introducing electrical tests for conductivity of iron wire, a practice which is now coming into use in England and elsewhere. They have also employed experimentally a copper covered iron wire, produced by lapping a copper tape round the wire, or by electro-plating it. Although no great results have as yet been attained, the experiments seem to hold out a hope that we may shortly be in possession of a wire, which, with the lightness of number sixteen shall possess the strength of number eight and the conductivity of number four.

The wires are not pulled up so tight as ours, the relative strains being about 200 lbs. to 300 lbs., but our arms are closer together. The Britannia joint, universally employed here, is not used in America, but a curious and complex twisted joint is made, and is dipped into a bath of solder. Formerly joints were not soldered, and even to this day they do not solder their joints in Canada. As a striking proof of the advantage of soldering, Mr. Preece mentioned that a line which before soldering gave a resistance as high as 23,500 ohms, fell to 1,400 after being soldered.

Throughout the vast system of the Western Union Company only one kind of insulator is used, viz., an annealed green glass one, which answers well in an American atmosphere, but which was long ago given up as useless in England. The insulators are made to screw on to wooden pegs, or brackets, and are easily and rapidly fixed. The wire is not bound in as with us, but one turn of No. 8 or 9 only being used as a tie wire. No shackles are employed, scarcely any stays or struts, and but few earth-wires. With us earth-wires, originally introduced as lightning protectors, are valuable as safe-guards against weather-contact. This is a difficulty with which the Americans are not much troubled. They get very heavy thunderstorms, yet they suffer less from lightning than we do, their lines being scattered over such vast spaces of country instead of being concentrated over a small area as in England. When a line is struck, however, it is sometimes a serious affair, as many as 200 poles having been destroyed at one time.

The lines are well and efficiently maintained, breakdowns being about as frequent as with us, and taking about the same time to repair. The responsibility of removing faults rests with the operating staff. Every manager of an office is responsible for the condition of the apparatus, and the chief operator does the testing,

such as it is. Few galvanometers are seen in the offices, the locality of a break being estimated by receiving the return shock on the fingers! There is an official called a repairer, who is a sort of cross between our "lineman" and our "inspector," who does the renewals, and who is paid from £150 to £200 per annum.

Closed circuits have been and still are the favourite system of working, although they are gradually giving place to open circuits, especially for long distances. They have the advantage of the batteries being all in one place; but the substitution of the open circuit effects a saving in battery power.

As regards instruments, the sounder is most generally used. Mr. Preece exhibited a few neat specimens, and spoke very highly in favour of the sounder, the use of which he has advocated for some years past. All the apparatus required to rig up an American office are a key, a relay, and a small sounder. On long circuits repeaters are used, the principal or "relay" stations being provided with several of them. In fine weather some of these can be cut out, but in bad weather have to be resorted to. Mr. Preece mentioned a remarkable fact, that no apparent loss of speed resulted from their employment. This is, of course, in direct variance with our experience here.

Compound or multiplex telegraphy is largely adopted in the States, the duplex, quadruplex, and various other "plexes" of Stearns, Edison, Prescott, Gray, and others, all coming in for a share of favour in telegraphic circles. It may be mentioned here that the quadruplex system as established on the London-Liverpool circuit by Messrs. Smith and Hamilton, who recently visited this country for that purpose, is in daily operation, and gives highly satisfactory results.

Type-printers are employed to some extent, principally the form elaborated by Mr. Phelps, on the basis of that invented many years since by Professor Hughes. They are, however, chiefly confined to private wires.

Edison's automatic system is used by the Atlantic and Pacific Company, and very flattering accounts of its performance are recorded. The maximum speed witnessed by Mr. Preece did not exceed 200 words per minute.

On the Chicago and Dubuque circuit there is a terminal telephonic circuit, in which through communication is carried on without interfering with the Morse working. The telephone, however, does not seem to play any great part, as yet, in commercial telegraphy.

In concluding his remarks upon the telegraph companies, Mr. Preece mentioned that he visited some of the workshops, and was surprised to find how few mechanics are employed. Much of the work which in England provides occupation for gangs of mechanics, in America is done by the operators, who, as beforementioned, are very skilful.

Some curious and characteristic terms are current in America, and Mr. Preece highly amused his audience by repeating a few of them. Thus, an operator is called a "plug;" to stop is to "break;" calling a station is "raising" it; contact is "cross-fire," &c.

One of the most efficient services in America is the fire-telegraph system, and, withal, one of the most important in a country where so much wood is used in building. In every town a most complete and perfect system of fire signals has been established. When a fire is observed, the alarmist has only to pull a handle or do something equally simple; this rings a bell at the fire-station and indicates the locality of the fire, so that in most cases fires are mastered before they can get head-way. The effect of this system has been to render the American fire brigades expert to a degree which is quite incomprehensible to us. Mr. Preece states that he and Mr. Fischer, when inspecting the working of the system, timed the operation of getting an engine out and away. A gong was sounded, the same current which gave the signal serving to release the horses, who, trained to their work, moved mechanically to their places at the engine; the men jumped up and away they went. The mean of three observations gave 8 seconds as the time elapsed from the sounding of the alarm to the starting of the engine. Mr. Preece also testified to a still more perfect state of things as existing at Chicago. There the signal-current not only sounds the gong and unhitches the horses, but it also draws the bolts from a series of trap-doors; and, that nothing may be left undone, it whips the clothes off the men whose beds are so placed with regard to the trap-doors that they are gently slid down into their places ready for a start! (It was not stated whether the men turn in with their uniform on, or whether the current puts this on for them).

But even this close approach to automatism is not left unsurpassed; for many buildings are provided with automatic alarms which upon any abnormal increase of temperature close a circuit and "sound an alarm."

Domestic comfort is studied and ministered to in a variety of ways. Compact, and not unsightly, little boxes are fixed up in a convenient place in the house. This box has a dial divided into compartments headed, respectively, messenger, doctor, cab, &c., and a pointer which can be set to any of these compartments. By simply pressing a lever, the person's wants are at once made known at the nearest call-station, as also the house from which the call proceeded, and in the briefest possible time the required person or article puts in an appearance.

With regard to the general question of the organisation of the staff, the American telegraph system is characterised by far greater elasticity than ours, more being left to the discretion and *savoir faire* of the officials than is the case with us. The result cannot fail to be beneficial to the service; each man knows that his success in life depends upon the aptitude and administrative capacity displayed by him; a wholesome spirit of emulation is thereby established, and there is, consequently, far less of that half-hearted service which too frequently characterises the English *employé*.

Financially considered, the American telegraphs are a greater success than the English; they "pay" better. It must be remembered, however, that they are still in the possession of joint stock companies, and that, therefore, unimportant places are left out in the cold, only those places which can offer a fair amount of traffic being served. In England the system has been enormously developed, since its acquisition by the Post Office, upon principles of national utility rather than with an eye to large revenues.

In view of these and other considerations, Mr. Preece would not attempt any close comparison between the two systems: each is admirable in its own way, and neither can be said to be in advance of the other. In America the carrying capacity of the wires has been increased by the introduction of multiplex working; in England the same end has been sought, and to a great extent attained, by the perfecting of fast speed instruments, such as the Wheatstone automatic, &c.

In the matter of invention there are some notable points of difference between the two countries, and the comparison is apparently unfavourable to us. Here, it is the fashion to keep an invention secret, and an inventor has to rely principally upon his own private resources. In America, invention is subsidised—in fact, men are paid to invent. Mr. Edison, one of the most eminent electricians of the day, is retained by the Western Union Co., and furnished with a magnificent, well-

appointed, experimental laboratory for the sole purpose of inventing. It is needless to point out that Mr. Edison's labours have not been unfruitful. In America, too, if a man hits upon a happy idea, it is taken up, and he is assisted to put it into practical shape. These facts were adduced by Mr. Preece as an appropriate answer to those pessimists who complain that we stand with our hands in our pockets waiting to take our "cue" from America. Perhaps it may also be regarded by some as an argument in favour of the "endowment of research," so much talked of now-a-days.

At the conclusion of the lecture, which was illustrated by diagrams and by the exhibition of some representative instruments, insulators, and other objects employed in America, a cordial vote of thanks to Mr. Preece, for his able and entertaining discourse, was moved by Sir Chas. Bright, and seconded by Professor Hughes, and carried by acclamation.

THE INSTITUTION OF CIVIL ENGINEERS.

AT the meeting on Tuesday, the 26th of February, Mr. W. H. BARLOW, Vice-President, in the chair, the Paper read was on "Liquid Fuels," by Mr. H. Aydon.

It was stated that apparatus specifically adapted for the combustion of liquid fuels, which comprised every class of fluid hydro-carbons, might be ranged in five classes. The leading principle of their action was either the subdivision of the liquid as spray, or by percolation through a porus bed, or by preliminary conversion into vapour,—when the fuel was mixed with air, or with air and steam, by the instrumentality of jets of steam or of compressed air, or it was burned simply as gas in jets. The earlier system of Mr. C. J. Richardson, in which the liquid fuel, mixed with heated air, percolated upwards through a porous bed, was tried at Woolwich Dockyard, but the performance was not satisfactory, for black smoke and soot were discharged in such abundance as speedily to choke the flue-tubes and stifle the draught. By a subsequent improvement, in which a mixture of steam was introduced with the fuel, a much better performance was effected—the quantity of water evaporated having been increased from 6½lbs. per lb. of fuel to from 7 lbs. to 18½ lbs. per lb. of fuel, though the formation of dense smoke was not prevented. The performance of coal under the same boiler amounted to an evaporation of 8 lbs. of water per lb. of coal.

The system of Messrs. Simm and Barff, in which the liquid fuel was vaporised in a retort placed in the furnace, and burned in jets, was tried in 1866, on board the yacht "Minnie." The quantity of oil consumed amounted to one-third only of the corresponding quantity of coal. The system was afterwards tried with the addition of steam, and with better results, as the intensity of the combustion was increased, and smoke was prevented.

In the fourth system, patented by the author, in conjunction with Mr. Wise and Mr. Field, in 1865, the liquid fuel was summarily vaporised, by the injection of the liquid into the furnace by the instrumentality of steam, which might be superheated, the supply of air for combustion being at the same time drawn in as an induced current. By this plan, the materials could be instantly and thoroughly mixed and converted into vapour or gas before ignition took place. No alteration of the ordinary furnace or grate was needed, so that either coal or oil could be used. For burning oil, the grate-bars were covered with thin fire slabs and a few cinders; and the ash-pit doors were closed, to keep out surplus air. In March, 1867, this method of burning liquid fuel was tried at the works of Messrs. J. C. and J. Field, South Lambeth, in a Cornish boiler. The results of several days' experiments showed an average of 19½ lbs. of water evaporated per lb. of liquid fuel. The boiler previously evaporated 6½ lbs. of water per lb. of Aberdare coal. Similarly, experiments with a double-flue Galloway boiler, at the chemical works of Mr. Barnes, at Hackney Wick, gave a net evaporative performance of 25·3 lbs. of water per lb. of fuel. Experiments had been made with other boilers, in which the evaporative efficiency of the liquid fuel ranged from 1½ to 3 times that of coal. Equally good results in favour of liquid fuel were obtained from its employment under a marine boiler at Woolwich Dockyard.

The fifth system enumerated, the invention of Mr. Dorsett, in which the liquid fuel was vaporised in a separate boiler or retort, to be burned as a gas, was tried in 1868, at the chemical works of the inventor, at Deptford, and also on board the "Retriever" steamer. The results in favour of liquid fuel showed a reduced consumption in the ratio of 2·5 or 2·7 to 1 as compared with coal; but against this economy had to be placed the cost of the separate generators and their furnaces, and of a force-pump. The retort, too, was liable to explosion, in consequence of the deposit of solid carbon within it.

The first employment of the author's system in metallurgical operations was at the Millwall Iron Works. The oil furnace was an adaptation of an old scrap iron furnace. It was fitted with bricks, and was used as a combustion chamber. Three oil injectors played directly upon the metal to be heated, lengthwise of the furnace.

The furnace consumed 6,720 lbs. of coal in twelve hours to keep up the heat, against 1,405 lbs. of liquid fuel, showing a ratio of 4¾ to 1 in favour of the oil, the consumption of which was at the rate of 17 lbs. per cwt. of iron. The loss of iron treated by coal was from 22 to 25 per cent., whereas with liquid fuel it was only 11½ per cent. by system 4, and 16½ per cent. by system 5.

The author, in 1875, proceeded to Canada, to experiment on the reduction and smelting of the refractory iron ores of that country, many of which were magnetic, and contained 32 per cent. of titanic sand. The experiments proved satisfactory, and pig iron was readily produced from the ore; though it was found that oil-fuel in smelting operations must be used in connection with an air-blast under pressure.

In the discussion on Mr. Aydon's paper, Admiral Selwyn advocated the use of oil as fuel specially on the ground of its applicability to vessels of the Royal Navy, which could now only store sufficient coal for three days' consumption at full speed, but that in the same space enough oil could be stored for nine days, an invaluable gain when in pursuit of an enemy. He remarked that oil was the only fuel which gave almost the full calorific result which theory would indicate, whereas with coal the loss was considerable. He also said that the heat produced by oil was so great, that the steam serving to inject the oil was decomposed into its constituents hydrogen and oxygen, the oxygen uniting with the carbon in the oil forming carbonic oxide, causing the heating effects to be somewhat greater than that due to the combustion of the oil less the loss of gas passing up the chimney. He looked to the mineral oils as the fuel of the future. Another speaker considered that oil was not at all cheaper than coal, and that it would be very dangerous in the hold of a vessel. He and a subsequent speaker considered the notion of steam affording additional heat was untenable. Mr. Crampton observed that the difference

in calorific effect between coal and petroleum, being about as 13 to 17, was so small as to give the oil only a slight advantage; that the use of oil was objectionable for sound reasons, and that the amount available was so small that if any considerable demand arose for it, the price would rise to such an extent as to make it much dearer than coal. Mr. Aydon, in reply, said that creosote was obtainable at one half-penny per gallon, and that he had got oil at one farthing per gallon; that mineral oils were found in most parts of the world, but that the chief value of oil as fuel was the small space it occupied.

At the meeting on Tuesday, the 5th of March, Mr. Bateman, President, in the chair, the Paper read was on "The Hooghly Floating Bridge," by Mr. Bradford Leslie, M. Inst. C.E.

This bridge connected Calcutta on the left with Howrah on the right bank of the Hooghly, at a short distance north of the East Indian Railway terminus. Various projects had been from time to time proposed; but ultimately the preference was given to a floating bridge, as it could be more cheaply and expeditiously constructed than a fixed bridge. The design was prepared in 1868, when it was intended to be carried out by a joint stock company; but after much delay, in 1872 it was undertaken through the agency of the Local Government of Bengal. The work was commenced in January 1873, and the bridge was opened for traffic in October 1874.

The present structure was the first, and, up to this date the only one of its kind affording headway for river navigation. It divided the port into two sections. The lower part was occupied by sea-going ships and steamers, and the upper part by inland craft and a few coasting vessels. As, however, the graving docks were above bridge, it was necessary that an opening should be provided for the passage of shipping. The extreme rise and fall of the tide during floods was 20 feet, and at certain seasons there was a tidal wave 6 feet in height. The maximum velocity of the stream was 6 miles an hour. The depth of the river at the site of the bridge was variable, the greatest depth at low water being 6 fathoms.

The bridge was 1,530 feet long between the abutments, and the roadway was 48 feet wide, with footpaths each 7 feet in width on both sides, so that the total width of the platform was 62 feet. There were four main longitudinal wrought-iron girders, at intervals of 16 feet in the width of the roadway, raised by timber trusses, resting upon pontoons, to a convenient height above the water for accommodating the boat navigation. The platform of the bridge was level for a distance of 384 feet on each side of the centre, at a height of 27 feet above the water. Thence it fell by inclines of 1 in 40 to a distance of 584 feet on each side of the centre line, where there was a length of 20 feet of level platform 22 feet above the water. Between these points and the abutments were the adjusting ways, the shore ends of which were 32 feet above low water. The approach on the adjusting ways was by a descent of 1 in 16 at extreme low water, and by a corresponding ascent at extreme high water; but at ordinary times it was either level, or only slightly inclined. The platforms of the adjusting ways were supported on the lower flanges of three bowstring girders, the roadway being divided into two by the centre girder. The footpaths were carried on cantilevers riveted to the outer girders. The bowstring girders were 160 feet long between the end pins on which they were hinged. The outer floating ends were hinged to pivot bearings, in order to admit of a slight drift up and down stream.

The floating portion of the bridge was carried on twenty-eight pontoons, coupled together in pairs to secure stability. With the exception of the two pairs in the centre, which supported the movable sections of the bridge, each pair carried 100 feet in length of the platform. Each pair was coupled together, at a maximum distance of 48 feet from centre to centre, by four timber cills bolted to the decks of the pontoons at intervals of 16 feet. These cills constituted the bottom members of the four main longitudinal trusses, the top members being the wrought-iron girders, carrying the roadway. With the exception of the upper girders, the whole of these trusses were of teak. The coupled pontoons were further connected by strong horizontal diagonal bracing of bar iron. The timber cills and the bracing being only four feet above the water, the space between the coupled pontoons was not available for navigation, and floating fenders or booms were provided to divert boats from these openings. Ordinarily the main girders overhung the pontoons 21 feet, their ends being supported by the inclined struts of the trusses, leaving a width for navigation of 42 feet, partially obstructed by the raking struts. For the convenience of the country craft, there were two rectangular openings of 60 feet clear span between the fourth and the fifth pairs of pontoons, reckoning from each abutment. The roadway over these openings was carried on eight girders.

All the pontoons were 160 feet long, by 10 feet beam, with holds varying from 8 to 11 feet in depth, according to the dead weight to be carried. Each pontoon, excepting those of the movable sections, was accurately anchored by permanent moorings, laid exactly in line with the centre of the pontoon, the distance between the up and the down stream anchors being 900 feet. The strain on the chain cables varied from 5 to 25 tons; their great length afforded the necesary "spring," to allow for the rise and fall of the tide, but a few links were taken in during the dry season, and slacked out again during the flood season.

The 200 feet opening for the passage of ships was one of the most difficult problems in designing the bridge. Owing to the strength and irregular set of the stream and eddies, ships could only be moved at or near slack tide; and it was a rule that all vessels of more than 200 tons must be moved by steam against the tide. The bridge was generally opened twice a week at high water, but occasionally at low water. The opening was effected by removing the two centre sections of the bridge bodily. These sections were connected with the fixed portions of the bridge by drawbridges, which on being run back left a clearance of 20 feet on each side of the platform of the movable sections. By means of steel warps, laid to buoys moored for the purpose, these sections were warped up stream far enough to clear the rest of the bridge. They were then disconnected and sheared over, one on each side, leaving a fair way clear of all obstructions. The bridge was closed by reversing these proceedings. The ordinary time taken in opening the bridge was fifteen minutes, and in closing it twenty minutes.

There was a daily traffic of about 6,000 tons of heavy goods, which were conveyed in bullock carts, besides foot and carriage passengers.

An accident delayed the completion of the work about three months. This arose from a deeply-laden ship fouling two vessels, which parted from their moorings, and both were sent up stream on the top of the "bore" at the rate of 5 knots an hour. One vessel went through the centre opening, but the other struck the bridge, causing three pontoons to be sunk, and the superstructure to be completely wrecked.

In the discussion which followed, some difference of

opinion was expressed with reference to the choice of a floating bridge in preference to a fixed one. It was stated that some proposals had been recently made for erecting a fixed bridge rather higher up the river, at a cost of about £200,000, which was mentioned as about the cost of the floating bridge. Some floating bridges erected in the United States and Canada were referred to; but the only instance given of a floating bridge, in which the platform was raised to any extent above the water, like the Hooghly bridge, was a bridge at St. Petersburg. The advantages possessed by a floating bridge, in being easily repaired if damaged by vessels drifting against it in a cyclone, were pointed out; and also the peculiarly unstable nature of the bed of the Hooghly, rendering it uncertain to what depth it might be necessary to carry down the foundations for a fixed bridge. The gentleman who, in Mr. Leslie's absence, replied to the objections raised, stated that the Government had objected to the erection of a fixed bridge, and endorsed the remarks made by other speakers, that a fixed bridge could not be erected on such a site at a less cost than £600,000. In answer to some remarks made about the insecurity of the moorings, he said that the anchors tended to sink in the silt, and had occasionally to be lifted. The bridge had efficiently, and in a short time, supplied a pressing want, and if at any time a fixed bridge was built, the present bridge could be shifted to another place.

PHYSICAL SOCIETY.—MARCH 2nd, 1878.

Professor W. G. ADAMS, President, in the chair.

THE following candidates were elected members of the society:—Mr. J. P. Kirhman and Dr. W. J. Russell, F.R.S.

Mr. SEDLEY TAYLOR exhibited the colours produced in thin films by sonorous vibrations. A piece of thin brass perforated with a triangular, circular, or rectangular aperture, and bearing a thin film of soap solution, was placed horizontally on one end of an L shaped tube; the beam of the electric lamp, after reflection from it, was received on a screen. It was shown that when a sound is emitted in the neighbourhood of the open end of the tube, the film takes up a regular form, which is indicated by the different colours of the reflected light, and each note has its own particular colour figure; and further, with different instruments we have different figures. Thus, when a square film was employed, a kind of coloured grating was the result, which was modified by changing the note, and with a circular film concentric rings traversed by two bars at right angles were observed.

Mr. W. H. PREECE exhibited and described the phonograph. After referring to the manner in which the preceding communication bore on the subject of the telephone, he went on to explain the construction of the two instruments exhibited, which have been made in accordance with the published accounts of the apparatus, and details received from the inventor, Mr. T. A. Edison, by Mr. Pidgeon and Mr. Stroh respectively. In the first of these the receiving and emitting discs are distinct, the former being of ferrotype iron, and the latter of paper, whereas in the second form of apparatus, both these functions are performed by one and the same disc of iron. They also differ in that, in Mr. Pidgeon's apparatus, the drum receives its motion by hand, and in that of Mr. Stroh a descending weight is caused to communicate motion by a suitable train of wheels, which motion can be controlled and regulated by an adjustable pair of vanes. In both cases the drum is of brass, traced over by a spiral groove, and the whole is mounted on a screw of the same pitch. The manner of using the phonograph is extremely simple. The drum having been covered with tin foil, a uniform movement of rotation is given to it, and a fine metal point, firmly fixed to the centre of the receiving plate is brought in contact with it, care being taken to place the point accurately over the groove. If now this plate be sung or spoken to, the tinfoil will be indented in accordance with the vibrations communicated to the plate. The emitting plate having been provided with a resonator, its point is now brought into the position initially occupied by the point of the receiving plate, and, on rotating the drum with the same velocity, fairly identical sounds are given out. It will be seen that Mr. Stroh's apparatus has an advantage over that of Mr. Pidgeon in that it secures a constant rate of rotation; but, on the other hand, the sounds emitted by the paper disc appeared to be more distinct than those from the iron. A number of experiments were performed with the instruments. The sounds were reproduced at times with remarkable distinctness, and when Mr. Spagnoletti and Mr. Sedley Taylor sang "God Save the Queen," as a duet, through a double mouthpiece, the two voices could be clearly distinguished on its being reproduced. It was shown that even when an indented sheet of tinfoil has been employed to emit sounds, it retains its form with such perfectness, that the sounds can be reproduced by means of it a second and even a third time with nearly equal distinctness.

Prof. GRAHAM BELL pointed out that the articulation of the instruments was very similar to what he had observed in the earlier forms of telephone, and he had no doubt, judging from his own experience of that instrument, that the phonograph will ere long be so adjusted as to articulate much more perfectly. He anticipated that the *quality* of the sound would be found to vary as the rate of rotation was altered, as well as the pitch, and this proved on experiment to be the case.

THE METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this Society was held on Wednesday, the 20th inst., at the Institution of Civil Engineers, Mr. C. Greaves, F.G.S., President, in the chair, when Dr. Tripe read a Paper on "The Winter Climate of some English Sea-side Health Resorts." The places selected were Scilly, Torquay, Penzance, Guernsey, Barnstaple, Ventnor, Llandudno, Ramsgate, and Hastings, and the climatic features of each were compared with those of London. The results of this discussion may be briefly summed up as follows, viz:—The mean daily winter temperature of these seaside places, and especially of those situated on the coast of Devon and Scilly, is higher than at London; the mean daily maxima and minima are also higher, and especially the latter, so that the daily and monthly ranges of temperature are smaller; the mean humidity is less; the general direction of the wind about the same, but the number of rainy days and the rainfall are greater at the sea-side. As regards the wind, therefore, the chief point to be especially noticed is the amount of shelter afforded by high land, as at Ventnor, and especially of protection against the stormy and cold winds which ordinarily prevail at the end of February and in March. The soil also should be considered, as heavy rains at gravelly and chalky places are not so objectionable as on clayey ground. The discussion on this paper was adjourned until the next meeting which will be held on March 20th.

General Science Columns.

THE TAY BRIDGE.

Early in the year 1871, the necessities of the traffic on the North British Railway, made it evident that the ferries over the Firths of Forth and Tay were unequal to the conveyance of the traffic on that great main railway artery of Scotland. The same year saw the commencement of the Tay Bridge, and a scheme for a Firth of Forth Bridge has since that date been successfully carried through Parliament by the North British Railway Company. The Tay Bridge, which forms a portion of the new branch railway from Leuchars, on the Fife line to Dundee, consists of a bridge almost two miles in length, over a rapid tidal river, having a bottom chiefly formed by alluvial deposit. The original design of the bridge comprised 89 spans of varying lengths, six of 28 feet, twenty-five of 66 feet, sixteen of 120 feet, and one of 160 feet on the Dundee side of the centre; and three of 60 feet, two of 80 feet, twenty-two of 120 feet, and fourteen of 200 feet on the Firth side. The experience gained in the course of the construction of the work rendered many alterations in this arrangement necessary. In the original design the piers were to be built of brick, set in cement, the foundations being produced by sunk cylinders filled with concrete. This plan was carried out on the Firth side with considerable success, the cylinders being sunk by the ordinary pneumatic process known as the "air-bell" process. Fifteen of the piers on the Fifeshire coast were thus erected, but on the 10th of March 1873, Mr. Charles De Bergue, the contractor, died, when progress was for a time checked, and new arrangements were rendered necessary. By this time also a considerable amount of work had been erected at the Dundee end of the bridge, where the piers were formed of hollow cast-iron tubes braced together with tie-bars, and sunk in the sand by means of a constant current of water forced through them. In July 1874, the completion of the work thus commenced was undertaken by Messrs. Hopkins, Gilkes, and Co., and the work, which had never actually stopped was resumed with vigour. For several reasons, Mr. Thomas Bouch, the engineer, at this time decided to modify his original design, and, instead of the plan above described, after very careful consideration, it was resolved to widen the centre spans, to adopt single large caissons, instead of two to each pier, and to make other important changes, which both added to the strength of the work and shortened the time required for its completion. The total length of the bridge is 10,321 feet, consisting of 84 spans, as follows:—

6	spans of	27	feet.	
14	"	67	"	6 inches.
14	"	70	"	6 "
2	"	88	"	
21	"	129	"	6 "
13	"	146	"	
1	"	162	"	
1	"	170	"	bowstring girder.
13	"	245	"	

Fourteen only of the piers, those on the Fife coast, are of brick, all the rest being of combined cast and wrought iron of various strengths, and composed of varying numbers of columns. The height of the largest girders above high water line is 88 feet, the line of rails being on a rising gradient from the Dundee end of about 1 in 73. The girders are of lattice construction, with double triangulation, and trough booms at top and bottom, from 15 in. to 24 in. in width according to the span, a vertical tie being fixed from the bottom boom to the crossing of the struts and ties, at every alternate crossing. The depth of the girders is one-eighth of the span. The cross girders are of pitch pine 12 in. by 9 in., the rails being carried on longitudinal beams 17 in. by 7 in., and the whole planked with 3 in. memel, covered with asphalte. A light hand rail of 2¼ in. (inside) gas tubes runs the whole length of the bridge, carried by metal stanchions. These tubes it is intended to utilise—the one to convey water and the other gas from one side of the Tay to the other. Across the long spans of 245 feet, the engines and trains will run between the girders, the rail platform resting on the bottom booms, but in all the other spans the trains will run on platforms fixed on the upper booms. The caissons employed for the larger spans are 31 feet in diameter, and about 20 feet deep, formed of wrought iron plates ⅝ in. thick, riveted together, and lined with brickwork 15 in. thick. Above this a further length of 20 feet of caisson was then built, and the whole floated out to its proper site, and sunk by means of sand pumps. As soon as the caisson was in position, it was protected from the scour of the water by depositing rubble stone round its base. As soon as it was sunk to the required depth, the centre was filled in with cement concrete, the upper portion was then removed, and on the concrete was placed a base for the pier constructed on shore, and floated out. This reached to the level of low water, and on it, as the tide permitted, men worked at the erection of the next section which reached to high water mark, where four courses of stone were fixed. On these were placed the iron columns, 12 in. and 15 in. in diameter, carrying the girders. When the piers were brought up to the proper height the girders were floated out on pontoons, and raised by means of hydraulic machinery to their respective sites. This bridge, the longest in the world, has been completed, and, having recently passed the Government inspection, is now ready to be opened for traffic. The test supplied to the bridge consisted of six engines, each 72 tons in weight, during the transit of which the greatest deflection recorded was only 1⅜ inches.

WORKS ON THE GREAT WESTERN RAILWAY.

The increasing traffic on the Great Western Railway has, for some time past, caused great inconvenience in the management of the train service within the Metropolitan District, and in order to obviate this, the Company has recently incurred very considerable expense in

laying down two new lines of rails, and in constructing new platforms and waiting rooms, besides, in some cases, entirely rebuilding the stations between Paddington and Southall, and it is intended to continue these improvements eventually as far as Slough. In connection with the general arrangements for facilitating traffic, it has been considered desirable to do away with the level crossing over the Great Western main line metals by the Metropolitan Railway, which was a constant source of delay to main line trains, besides being a standing element of danger. Since the extension of the Metropolitan system to Hammersmith, the trains on that line and the Great Western trains have crossed at points situated between the Ranelagh and Westbourne bridges, near the entrance to the goods station, and in order to obviate this inconvenience, a sunken way has been constructed between Westbourne Junction and the Royal Oak station for the use of the Hammersmith and City trains, and a rearrangement has been made of the main up and down trains of the Great Western between Paddington and Westbourne. Commencing at a spot opposite the west-end of the locomotive sheds, the sunken way dips with an incline of 1 in. 60, to a depth of 17 feet at its lowest part, extending for a distance of about half a mile to near the Royal Oak station. The sides of the cutting are formed of concrete walls, capped by coping bricks, and surmounted by a light iron handrail. The bottom of the cutting being below the sewage system, the drainage will have to be pumped out by means of a steam engine. This sub-way will provide a clear route for the Hammersmith and City trains, two lines of rails being laid in it for the up and down services. In order to provide space for the arrangements necessary to enable the Great Western Railway to cross the Hammersmith lines, the carriage sheds on the south of the railway have been demolished, and a route has been cleared by the side of the present Royal Oak station. On leaving Paddington the Great Western main line trains will pass on the south of the Royal Oak station, along the yard to a point about the middle of the sunken way, where the lines of rail are carried over the Hammersmith and City Railway upon strong iron girders, joining the main line near the east end of the locomotive depot. The carriage sheds having been demolished, it was necessary to provide accommodation for rolling stock, repairs, &c., on another site, and an extensive range of buildings have been erected for this purpose on the triangular space of waste land adjoining the Gas Works, near Wormwood Scrubs. It is expected that the sub-way will be opened for traffic in about a month from the present time.

HUXLEY'S PHYSIOGRAPHY.—Physiography is a subject not only interesting, but useful to the telegraph engineer. An intelligent knowledge of the natural phenomena of the earth's surface and the great processes of change perpetually going on in all countries is proper culture for a man who travels, and may be valuable education for an engineer. Professor Huxley's recent treatise on "Physiography" (Macmillan & Co.), is an excellent little manual of the subject in every way. It is pleasant to read, lucid in its explanation, and so admirably organised, that one has only to study it carefully from beginning to end, in order to form "a clear mental picture of the order which pervades the multiform and endlessly shifting phenomena of nature." Contrary to the usual practice in works on "Physical Geography" of beginning with a definition of the earth's figure and position in the solar system, Mr. Huxley begins with the firm ground of common experience, the features of a river basin, such as the Thames, and leads his readers by chapters on the nature and action of springs, rain, snow, the atmosphere, the sea, earthquakes, and volcanoes, coral and foraminifera, to a comprehension of the active agents of terrestrial change and the distribution of land and water; then deals with the figure of the earth and its movements round the sun. On the subject of ocean currents we find the following remarks at page 177. "During the recent voyage of the *Challenger*, the temperature of the sea at different depths was very carefully examined by means of instruments specially constructed to avoid sources of error. These observations shew that, as a rule, the temperature diminishes as you descend, just as was shown to be the case in the North Atlantic. Reference to fig. 45, shews that the bottom-water of that part of the ocean has a temperature only a little above 30° F.; while in other places it is still lower, and may even descend below the freezing-point of fresh water. It appears that the presence of such cold water in the deeper parts of the ocean, even in tropical regions, can hardly be explained otherwise than by assuming a grand movement of water from the polar towards the equatorial regions. Dr. Carpenter has brought forward much evidence to prove the existence of such a general oceanic circulation, and he refers the movement mainly to differences of density due to differences of temperature. The cold polar waters sinks by their density and form a deep layer, which creeps along the ocean-floor towards the equatorial regions; while the warmer and relatively lighter water floats on the surface in a contrary direction, or from equatorial towards polar areas. By such means, a complete circulation might be established; and it has consequently been said that every drop of water in the open ocean may, in course of time, be brought up from the greatest depths to the surface. Other meteorological conditions, however, may exert an influence of the same kind, as great as, or even greater than, that produced by difference of temperature. Sir Wyville Thomson regards the influx of cold water into the Pacific and Atlantic Oceans from the south as an indraught due to "the excess of evaporation over precipitation in the northern portion of the land hemisphere."

STEWART'S PATENT FLAG-SIGNAL FOR RAILWAY CARRIAGES.—In railway trains built up of isolated car-

riages, as those in this country invariably are, it becomes absolutely necessary as a matter of security to travellers for some means of inter-communication between the passengers and the guard or engine-driver of a train, to be provided. Many trains are now fitted up with a patented appliance, whereby the guard can be alarmed. The recent episode on the Midland Scotch Mail, however, in which the passengers in a compartment had for their own safety to get out and cling to the side of the carriage, while a free fight was going on inside between two drunken men, is a case which shews that although the appliance is ostensibly there, it is not always in working order. Mr. Stewart's system consists not only in ringing a bell to alarm the guard and the engine-driver, but in putting out a danger flag from the carriage in which help is required. Both acts are done simultaneously by the mere pulling of a cord which runs round the roof of each compartment, so as to be within easy reach of every person there. The pulling of this cord springs a trigger, liberating the flag which shoots out from the side of the carriage and unfurls itself in the air. At the same time, the flag-staff completes the circuit of a Léclanché battery, and rings a bell in the guard's van. The line wire is led along the top of the carriages, and the rails may be used as a return wire. The bell continues to sound until the flag is replaced and held back by its trigger, and as the position of the flag with regard to the carriage prevents the passengers from doing this, it can only be done by the guard answering the call. An electrical alarm is far more prompt and satisfactory than a merely mechanical one depending on the forcible pulling in of a slack cord. Mr. Stewart's has the merit of being simple, and above all of being readily accessible at every part of the carriage. The danger flag is also an important adjunct to the alarm bell, since it indicates the carriage at once to the guard, and can also be seen by porters or signalmen working on the line. Messrs. Heinke and Davis, Philpot-lane, are the makers of this appliance.

STEINER'S TASEOMETER.—Mr. Steiner, of Vienna, has lately constructed an apparatus for measuring the strains of structures, which he calls a "taseometer." Although the principle embodied in this instrument is not new, yet the construction of the apparatus is a decided improvement.

It is well known that the note given out by a stretched wire, or strip of metal, depends on the tension to which this wire or strip is subjected. Now, it has been already proposed to utilise this fact for measuring the strains on the various members of bridges or other structures. For this purpose a wire was to be stretched along the body or bar to be tested, and, as the ends of the wire would be firmly attached to the bar, the wire would vary in length by the same amount as the bar. It would thus only be necessary to measure the variation in length of the bar, and this was to be done by comparing the tone given out by it after the load had been applied to the bar, with that before the application of the load. As, however, this comparison had to be done by the ear, it is evident that no very exact results could be obtained, for it required a highly cultivated musical sense to discern various intervals of tones, the more so when the two tones are not sounded in immediate succession.

In Mr. Steiner's taseometer, this fault is done away with by automatic registration of the tones, the vibrating wire, or rather steel band, tracing its motions on a sooted surface in the same way as in the well-known phanantograph. The vibrations of a tuning fork, which is sounded at the same time, are shewn graphically on the same sooted surface, and serve as a standard by which the vibrations of the steel band are measured. Thus not only is any uncertainty in judging of the various tones avoided, but the tables with the vibratory curves inscribed on them can be also kept as lasting documents of the tests and experiments made, and the calculation of the strains from these curves can be done at leisure at any time and place that might be found convenient.—*Engineering.*

TRAFFIC ON THE METROPOLITAN RAILWAY.—At the last half-yearly meeting of the Metropolitan Railway Company, the chairman stated that 442 trains were run over the main line in 24 hours, and 568 on the widened lines, making a total of 1010 trains in that time. The first engine on the main line leaves the shed at 5·15 a.m., and the last engine reaches the shed at 1·15 next morning; on the widened lines work goes on throughout the 24 hours. During the day and night 46,826 telegraph bell signals, and an equal number of train signals are made. The manipulation of levers backwards and forwards to work the signals and points amounts to 66,958 times in the 24 hours; therefore in the mere signalling and working of the trains upon the block and interlocking systems, there are 160,000 operations daily performed by human hands, every one of which might lead to some mistake which might be more or less injurious.

NICKEL AND NICKEL-PLATING.—Until within the last few years, the only source for nickel was the "matte," or "speiss" ores, highly complex arsenides or sulphides of nickel, associated with cobalt, copper bismuth, and other metals. The cobalt had to be separated from the nickel by a special process. Recently, however, ores of nickel almost entirely free from arsenic, sulphur, copper, and other metals precipitable from acid solutions by sulphuretted hydrogen, have been discovered in New Caledonia. This ore consists essentially of hydrated silicate of nickel and magnesium, with iron sometimes associated. Silicate of nickel has already been found in other parts, for instance at Malaga in Spain, but ores so rich in the metal as the New Caledonian ores have never before been known. Former ores, in many cases, only gave three or four per cent. of the metal, but the new ore generally gives from ten to twenty-five per cent. The mineral is amorphous and traversed by fissures which

are often filled in with white silica in thin plates. It is of a bright green colour when rich in nickel, and almost rivals the lighter shades of malachite. Mr. Alfred H. Allen, F.C.S., in a paper to the chemical section of the Society of Arts, has published the results and methods of his analysis of it. At least half a dozen patents have been taken out for the extraction of nickel from the new ore. The ultimate product of every one of these processes is always pure oxide of nickel, which is reduced by heating it in pots along with charcoal. The masses known as "cube nickel," are made by mixing the oxide with wheat flower and water, so as to form a paste, which is cut into cubes and dried. These are heated in a crucible with plumbago powder and the pure metal is reduced. Commercial nickel varies much in quality; "nickel coins," so called, contain generally two-thirds of their weight of copper. Copper is not objectionable in nickel to be used for the manufacture of German silver, but the presence of traces of iron, sulphur, lead, and antimony should be carefully avoided. Like iron, nickel is rendered more fusible by the addition of a little carbon or silicon. "Pure nickel," says Mr. Allen, "is well known to require a very high temperature for its fusion, and when this difficulty is overcome, it is difficult to obtain the casting free of bubbles. Professor Winkler has recently achieved great success in this direction, and has obtained large and compact ingots of pure nickel and cobalt by ensuring a sufficiently high temperature, suitable pots, taking precautions to keep out carbon and silicon, and casting in an atmosphere free from oxygen. For the fusion he employs a porcelain crucible, which last is inserted in a graphite crucible and imbedded in fire clay. To obtain castings free from bubbles, it is found necessary to pour the metal into the mould through a flame of burning petroleum."

Nickel plates, for anodes in nickel-plating, are more and more in demand. The metal is melted in ordinary steel pots, a little borax or other flux being added. A small proportion of tin added to the metal makes it more fusible, and is not deleterious to the anode. Many patents have been taken out for the electro-deposition of nickel from solutions, but, practically, the only solution employed is the double sulphate of nickel and ammonium. It should not have a higher density than 1030, and should be alkaline rather than acid. The current should be carefully regulated, else the deposit loses its lustre. Almost any metal may be coated with a layer of any required thickness. For iron articles it is very well suited, and many pieces of telegraphic apparatus, such as the adjusting magnets of galvanometers, the iron poles of relays, and tongues of sounders, are now plated with it. The metal has a silvery white lustre, and is but little liable to tarnish in a fairly dry atmosphere, but fails to withstand continuous dampness. The New Caledonian ore is singularly well adapted for nickel-plating, and if it can be found in sufficient quantities we may expect a wide extension of nickel-plating.

GALLIUM.—Sixty-two grammes of the metal gallium were recently exhibited at a *séance* of the French Academy of Sciences, in the liquid form, in plates, in bars, and in magnificent crystals of many facets. To procure this quantity it was necessary to treat 5,000 kilogrammes of blende. The liquid metal resembles mercury in appearance, and, were it sufficiently abundant, might be employed in thermometers to indicate high temperatures, since it does not volatilise like mercury.

COLUMBIUM.—This little known metal was discovered in 1861 by Hatchett, an American chemist. He extracted it from a very rare mineral called columbite. It has hitherto been prepared in the form of a black powder, and its price was about a shilling per grain. Recently, however, it has been found in considerable quantities in the Amazon-stone of Colorado, and it is not unlikely that we shall hear more of it. In colour it comes between nickel and tin; it is lighter than tin; and in chemical properties it appears to come between tin and bismuth or antimony.

A NEW EXPLOSIVE.—It is said that Mr. Nobel, the inventor of dynamite, has discovered an explosive, even more potent, in "blasting gelatine." It is composed of 93 or 94 per cent. of nitro-glycerine, and 6 or 7 per cent. of collodion-cotton mixed together so as to form a gelatinous substance. It is tough, but may be cut with a knife or scissors, and may be made into cartridges, cakes, or balls.

A SCIENTIFIC COLONY in the artic regions is about to be established by the Americans, at Lady Franklin Bay, near where the coal seam was discovered by Captain Nares. Substantial buildings and provisions for three years are to be transported thither. Competent scientists, appointed by the National Academy of Sciences, and provided with the requisite apparatus for observations, are to form the principal members of the expedition. The telephone will be employed in maintaining communications, and balloons will also be made use of. It is thought that such a colony will in course of time become a base of operations from which parties may ultimately reach the pole.

City Notes.

Old Broad Street, March 14th, 1878.

WE hear that the Pouyer Quertier scheme is making steady progress. If it is not brought before the public until the French Exhibition is over, it certainly will afterwards, unless, indeed, as some think, there will be no necessity to ask for the support of the public. As we have already stated, half the capital has been subscribed privately, and it is more than probable that the other half will be obtained in the same way, in which case the monopolists may awake some fine morning and find the French Cable a stern reality.

It is highly satisfactory to learn from the managing director of the Black Sea Telegraph Company that

Mons. Lacoine has stated that during the recent repairs of the Constantinople to Odessa Cable, the Constantinople to Varna Cable of 1854 was hooked, and the portion taken out found to be in perfect condition after twenty-four years' immersion. No such striking proof of the durability of cables as this has hitherto been forthcoming, and it may well be a matter for congratulation amongst shareholders in telegraph companies all over the world. Twenty-four years is a long period, and if cables will remain perfect after all that time how long may they be expected to last?

At a meeting of the directors of the Indo-European Telegraph Company, on Tuesday, it was determined to recommend to the shareholders the payment of a dividend, for the year 1877, of 3 per cent., free of income tax.

A general meeting of the shareholders of the Great Northern Telegraph Company is announced to be held at Copenhagen on Saturday, the 6th of April. Some of the English shareholders may like to make the trip. The business to be transacted is not of an exciting character. A report of the business for 1877, and of the condition of the cables and all other property of the company, will be submitted, and one member of the board is to be elected.

It seems difficult to doubt that the majority of the shareholders of the Chatham and Dover Railway Company had substantial reasons, the other day, for definitely deciding against amalgamation with the South Eastern Company. But we take leave to observe that while the opponents of the fusion were, of course, at perfect liberty to oppose it, they were not justified in referring to the South Eastern Board in terms of something very similar to opprobrium. It does not follow that because certain noisy speakers at the Cannon Street meeting tried to show that the Chatham Company is all righteousness and the South Eastern Company the reverse, and certain sixth-rate newspapers with terribly limited circulation and still less honesty of purpose, find it to their advantage to thwart the proposed union, it was, therefore, supported by the South Eastern Board with the solitary object of benefiting South Eastern Shareholders at the expense of Chatham and Dover. As a matter of fact when the idea of fusion was first mooted, some of the persons who have lately been unable to discover language strong enough to denounce it, pronounced in its favour. It is now undoubtedly settled that the scheme is to be abandoned, and we do not know that it would serve any purpose to discuss the details of it. We content ourselves with two further observations. The insinuation of a paper which imagines it represents railway interests, closes a palpable puff of the Chatham Company and its boisterous panegyrists, with the intimation that the scheme was hurried on by the representatives of the Stock Exchange. To that extent we share the opinion of the print in question, although perhaps, we have a different opinion concerning the representatives themselves. But the last move of the representatives of the Stock Exchange seems to us to be worse than the first. It is true that the holders of Chatham stock are entitled to some commiseration, but the desperate expedient of trying to improve property by a demonstration against a competing company, may eventually recoil on the heads of those who are responsible for it. In the second place, whether the rupture between the companies—which were until recently on such a friendly footing towards each other—is a good or a bad thing, the notion of railway amalgamation of any kind may now finally be dismissed by the public. Possibly "enterprising" speculators may from time to time contrive to spread rumours of "negotiations," but even if the rumours are apparently backed by authority, our advice is, treat them with contempt, and above all, have no faith in the company which having striven for union retires from the scene, because it finds that the other company sets no higher value on its property than it deserves. In other words, profit by the examples of the Great Eastern, the Manchester Sheffield and Lincoln, and the Chatham and Dover Companies.

Perhaps it is right we should add that our strictures are not in any way directed at the chairman of the Chatham Company who almost went out of his way to say that he believed Sir Edward Watkin had acted as fairly and equitably towards the Chatham Company when the basis of the contemplated arrangement was made. We do not indeed assert that the opposition of the shareholders of the Chatham Company is not fully justified by the figures which have been placed before them, and as it is possible the fusion would not have worked for the advantage of the public, that may be one reason, at any rate, why it was not desirable. What we denounce is the course pursued at the Cannon Street meeting and elsewhere, by persons who previously supported the fusion, but who now can only deal out hard words to those who, like Mr. Branch think that what was good for the Chatham Company a year or two ago could not be so disastrous now. The interruption experienced by Mr. Branch was annoying, but the loud cheers which according to freely circulated pamphlets, greeted other speakers, have since been set down at their value.

We have spoken none the less freely about the abandonment of the fusion between the Chatham and South Eastern Companies because we have frequently felt it necessary to disagree, in the most decided manner, with Sir Edward Watkin. The circumstance that Sir Edward has now been paid with some of his own coin, and some even more alloyed, does not alter the fact that the chairman of the South Eastern Company and his co-directors have been unjustly vilified. It is likely that the break down of the proposed amalgamation with the Chatham Company will not tend to increase the dividend of the South Eastern Company for some time to come, for the competition which is often so advantageous to the public is frequently the cause of anxiety in the board-room of railway directors.

We have nothing to say touching the question at issue between Mr. James M'Henry, and certain of the proprietors of the Erie and Atlantic and Great Western Railway Companies. But there is one remark in the last circular published by Mr. M'Henry, which is well worthy of note. "Who would dare," asks Mr. M'Henry, "to propose as a remedy for the financial embarrassment of an English railway a sale by auction and destruction of all inferior creditors?" "A railway," he goes on, "cannot be benefited by foreclosure and sale, or by the 'wiping out' and 'scaling down' processes, familiar to American managers and lawyers, who appear to have no higher aim or juster knowledge of railway finance than to defy the owners, while squandering their proper revenues in enterprises destructive to the company and its customers. It was not by such means that the South-Eastern, Metropolitan, Brighton, or North British Railways, were elevated from disaster to prosperity." No, indeed, it was not; if such means had been used in the cases in question, we doubt whether either of the companies would have existed at the present moment. If there is much to be found fault with in the management and administration of railways, in this company, it is, at least certain, Americans themselves being judges, that the best thing some American companies could do would be to take a leaf out of the book of even one of the least successful.

THE TELEGRAPHIC JOURNAL.

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THE TELEPHONE IN COURT.

We propose to give in this article an abstract of Mr. Morgan Brown's specification of Bell's telephonic apparatus, pointing out what parts have been disclaimed by the disclaimer of Feb. 13th last. The specification is a long one, but as much of it is very material, we shall give the more important parts in the words of the original.

The patent is dated December 9th, 1877, and the invention is entitled, "Improvements in electric telephony (transmitting or causing sounds for telegraphing messages) and telephonic apparatus." The first idea one has on reading the preamble is that the invention is one relating to multiplex telegraphy, but the part which gives this idea has been struck out by the disclaimer, as will be seen from the extract given below, in which those parts struck out by the disclaimer are printed in italics and enclosed in brackets; those added are merely enclosed in brackets and not italicised.

"The present invention relates to the reproduction by the necessary receiving instruments of any particular sounds or combinations of sounds through the agency of an electric current, [*whereby a multiplicity of telegraphic messages may be sent simultaneously over a single circuit in the same or in opposite directions, and received without confusion, and*] whereby articulate speech may be electrically transmitted."

[*"The invention relates to the production or transmission of musical notes by means of undulatory currents of electricity, one battery being used for the whole circuit, whereby two or more telegraphic signals or messages can be transmitted simultaneously over a single circuit or in opposite directions."*] "The invention also relates to the electrical production or transmission [in the manner hereinafter described and claimed] of sounds of every kind by means of undulatory currents of electricity, whereby not only musical sounds but articulate speech can be transmitted over a telegraph line, [*and two or more messages be simultaneously sent over a single circuit in the same or in opposite directions*].

"The invention also relates to the electrical production or transmission [in the manner hereinafter described and claimed] of sounds of every kind without a battery [being used in the main circuit, or used otherwise than in the manner hereinafter described and claimed], by means of undulatory currents of electricity, whereby, not only musical notes but articulate speech can be transmitted over a telegraph line [*and two or more messages be sent simultaneously over a single circuit, in the same or in opposite directions*].

[*"The invention also relates to the automatic reception of signals or messages, by introducing at the receiving end of the line a local circuit, containing a vibratory circuit breaker, whereby telephonic signals or messages may be automatically recorded.*

"The invention also relates to the application of electric telephony to autographic telegraphy, whereby characters or marks of any description may be copied in facsimile at the receiving end of the line]."

The preamble is followed by a description of six plans; the first three of these relate to multiplex telegraphy by intermittent pulsatory and undulatory currents. Only the latter method is claimed in the original specification, and this is disclaimed by the disclaimer. As, however, it bears on the fourth and fifth plans, we give a short résumé of it.

Plan III.

Each transmitting instrument generates by one of the methods hereafter described undulatory currents, and the receiving instrument consists of a spring armature vibrating so as to sound a definite note, there being a different note for each receiving instrument, the instrument at any one place only sounding when the current corresponding in its undulations to the particular tone of vibration of the armature is passing. The method by which the undulatory currents are produced was itself also claimed, but now is disclaimed. The method is to cause a continuous current from a voltaic battery to be gradually increased and diminished in intensity, by the vibration or motion of bodies capable of inductive action, or by the vibration of the conducting wire in the neighbourhood of such bodies; or to increase and diminish the resistance of the circuit by making the current pass through a wire which dips to a varying extent into water, which forms a part of the circuit; or to increase or diminish the resistance of the battery by raising and lowering the plates in the liquid or making the plates approach to or recede from each other.

We now come to

Plan IV.

"In the plans so far described a separate instrument is employed for every pitch, and the electric vibration for different pitches are combined upon the wire, each armature being capable of transmitting or receiving but a single note, and thus as many separate instruments are required as there are messages or musical notes to transmit. In this part of the invention a single instrument is employed, the armature of which can be set in vibration by a musical instrument, or by the tones of the human voice, or by any sound whatever."

One of the ways in which the armature mentioned * may be set in vibration, was stated to be wind. Another mode is the human voice, or musical instrument, or any other sound. The way in which either is done is the following:—Instead of the armature in * being fixed to

* The method which is more particularly described consists in using an electric magnet with a coil round one leg only. A spring

the leg of the electro-magnet, it is hinged, or loosely fixed there. The free end is fixed to the centre of a stretched membrane, which is fixed across the smaller end of a conical tube. The receiver is exactly the same as the sender. It is stated that the receiver imparts to the air (where it is) a *fac-simile* copy of the motion of the air at the transmitter, "hence two or more musical notes, or telegraphic messages, can be sent simultaneously along a single circuit from one station to another by means of one instrument at each station."

It should be noticed by our readers that this apparatus is used with a battery. In the disclaimer it is stated :

"That no claim is made to the use of telephonic apparatus, wherein a membrane like goldbeaters' skin is used in combination with an electro-magnet, excited by a battery which is arranged in the main circuit or line wire, inasmuch as such a membrane was mentioned in descriptions published in England prior to December 9th, 1876, and as such a membrane is of small utility owing to its uncertainty of action caused by changes due to wear or moisture, or atmospheric influences."

The specification proceeds :

"Instead of the cone membrane and armature described above, a plate of thin steel may be used,"

The disclaimer adds :

"with greatly increased advantage as an armature."

The specification proceeds :

"The vibrations of the plate in front of the magnet, occasioned by the motion of the air during the production of sound changes the intensity of the current as hereinbefore described, and occasions a similar motion in a similar steel plate in front of another electro-magnet at another station in the circuit. . . . . . This invention is not limited, however, to the use of a steel plate, but includes within its scope any equivalent plate capable of inductive action upon a current of electricity.

"On this plan, an operator at one station may send a telegraphic message on a certain pitch, while another operator at another station is transmitting another message on a different pitch, and both sounds will be audible at all the stations in the circuit. The receiving operators will pay attention to signals of only one pitch, hence by this plan the simultaneous transmission of a number of telegraphic messages over a single circuit, in the same or both directions, with a single wire battery for the whole circuit, and a single telephonic instrument at each station is rendered possible. Whatever sound is made in the neighbourhood of any telephone is echoed in *fac-simile* by the telephones of all the other stations; hence this plan is also adapted for the entirely new use of transmitting intelligibly the exact sounds of articulate speech. All the methods of producing undulatory currents of electricity hereinbefore described, may be employed in producing the undulations by which to transmit articulate messages."

We now come to that part of the specification which deals with the telephone without a battery; hitherto, the specification has merely shown that the plan we marked*, in which a vibrating armature increases or diminishes a battery current, can be extended by using a vibrating steel plate in lieu of the armature. The modern telephone is described as

Plan V.

"In the fifth plan of the invention the battery is omitted, and a permanent magnet is substituted for the soft iron core of the electro-magnets used in the other telephones," or induction coils may be used, local batteries being placed in circuit with the primary wires, so as to magnetise the soft iron cores of the coils. The undulations induced in the secondary wires by the vibrations of the plates being directed upon the line wire. An illustration is given of the box telephone, and it is stated that the magnet employed may be of a horse-shoe form, the wire being wound round both legs [hitherto it has been described as round one only], and soft iron ends may be fixed on to the magnet, and the wire wound round those ends. "The coils will preferably be very thin, and placed at the extremity or extremities of the magnet. One, two, or more magnetic poles, with coils, may be used to intensify the effect. The soft iron core and coil may be attached to the plate instead of the magnet, or the core may be placed upon the plate, and the coil on the magnet, or *vice versa*. The magnet may be made to vibrate instead of the plate."

No illustration or particular description is given of the trumpet-shaped telephone, the one in general use.

The VI. Plan which relates to the transmission of writing is wholly disclaimed.

We now come to what is perhaps the most important part of all—the claims. These we give as they now stand. They were originally eighteen in number, but are now reduced to eight. The claims struck out are those which refer to Plans III. and IV., and three which claim the means of adjusting the plate and magnet in the box telephone, the sounding box, and speaking tube.

The claims which remain are as follows :

"First. The combination, substantially as set forth and described respectively in the fourth and fifth plans above referred to, of a permanent magnet (or other body capable of inductive action) with a closed circuit, so that the vibration of the one shall occasion electrical undulations in the other or in itself; and this I claim whether the permanent magnet be set in vibration in the neighbourhood of the conducting wire forming the circuit, or whether the conducting wire be set in vibration in the neighbourhood of the permanent magnet, or whether the conducting wire and the permanent magnet, both simultaneously, be set in vibration in each other's neighbourhood.

"Second. The method of transmitting vocal or other sounds electrically by causing the intensity of an electrical current generated as described in the fourth and fifth plans, to vary in a manner proportional to the variations of density produced in the air by the said sounds.

"Third. The method of transmitting vocal or other sounds electrically by causing the intensity and polarity of an electrical current generated as described in the fourth and fifth plans, to vary in a manner proportional to the velocity and the direction of motion of the particles of air during the production of the sounds.

"Fourth. The union upon and by means of an electric circuit of two or more telephones when constructed for operation, substantially as described in the fourth and fifth plans, so that if the plate armature of any one of the said instruments be moved in any manner the armatures of all the other telephones upon the same circuit will be moved in like manner; and if the trans-

armature is fixed to the other, and the free end lies over the bobbin leg. A current being sent through the wire, the armature becomes magnetic and of contrary polarity to the bobbin leg of the electro-magnet. As long as the armature remains at rest, no effect is produced on the current which flows steadily; but when it is made to vibrate by any means, "one of which is by wind," a powerful inductive action takes place, and an undulatory current traverses the wire.

mitter armature be moved or vibrated by sound, like sounds will be produced by the motion or vibration of the armature of the other telephones upon the circuit.

"Fifth. In a system of electric telegraph or telephony, consisting of transmitting and receiving instruments, such as are described in the fourth and fifth plans, united upon an electric circuit, I claim the production in the armature of each receiving instrument of any given motion by subjecting said armature to an attraction varying in intensity, however such variation may be produced in the magnet: and hence I claim the production of any given sound or sounds from the armature of the receiving instruments, such as are above mentioned by subjecting said armature to an attraction varying in intensity in such manner as to throw the armature into that form of vibration which characterises the given sound or sounds.

"Sixth. The combination in the manner described in the fourth and fifth plans, of an electro-magnet with a plate of iron or steel or other material capable of inductive action, which can be thrown into vibration by the movement of surrounding air, or by the attraction of a magnet.

"Seventh. In an electric telephone the combination with the plate of a magnet having coils upon the end or ends of the magnet nearest the plate, substantially as described in the fourth and fifth plans.

"Eighth. In an electric telephone the combination with a permanent magnet and plate armature of a soft iron pole piece forming the core for the coil, substantially as described" in the fourth and fifth plans.

HIGGINS' IMPROVED PRINTING TELEGRAPH INSTRUMENT.

No class of telegraph instrument is, perhaps, more useful for the distribution of information to a large number of stations simultaneously than the kind which prints in Roman type the message transmitted; and in no class has more ingenuity been displayed in effecting improvements which have for their object the production of a compact and simple instrument which can run at a comparatively high speed, and be free from a liability to skip letters, and which, should such skipping accidentally occur, is self adjusting, so that the error may not repeat itself beyond one revolution of the type wheel. Mr. Higgins' improved instrument seems to possess these particular qualifications in a high degree, and is, therefore, well worthy of notice.

The object aimed at by Mr. Higgins is mainly the construction of a printing telegraph instrument which can be worked on a single wire without the aid of clockwork for driving the type wheel.

The instrument consists of the following parts:—Either one or two type wheels fixed to a common axis and driven by a propelment, which is so constructed as to prevent the momentum of the type wheels carrying them beyond the desired point. For this purpose two pallets, carried by a rocking lever, act alternately on the top and bottom of a ratchet wheel on the axis of the type wheel, with pin stops for the pallets to come against at the end of their forward movement. An arrangement is also provided for bringing the type wheel to the zero point.

The armature which carries the pallets is composed of iron and brass, and is magnetised from a large fixed permanent magnet through the arbor of which it forms a part.

The transmitter sends alternate currents; the currents pass through (or cause other currents to pass through) coils or electro-magnets which are placed on either side of the magnetised armature.

The printing is effected by the current being diverted by a magnetic switch which is made rather sluggish of movement, and only acts when the current is caused to flow for a slightly longer time than when the type wheels are being rotated.

The circuit of the type magnets is closed at such times, and the whole force of the battery passes through the printing magnet, or a separate battery may be used for operating the printing.

The printing from one wheel or the other, when two are used, is controlled by an arrangement which traverses a shield to and fro to cover or uncover the paper below the wheel to be printed from, and at the same time brings a support below the printing pad beneath it, and so locks it and unlocks the printing pad under the one not being printed from.

Where figures are not much required one type wheel and a narrower band of paper and lighter printing mechanism may be employed. The arrangement will continue the same, but a greater number of contacts per revolution of the type wheel will be required.

Sixty or more characters may be used, but for the distribution of general intelligence thirty-six will be sufficient with a corresponding key board. For long distances an escapement and train of clockwork are employed, the other arrangements remaining the same; but the shunting magnet puts in operation a local battery instead of diverting the main current. The type wheel axis is connected to and obtains motion from the train by a light intermediate coiled spring; the pulsations are not therefore sensibly felt by the train.

Any form of transmitter which sends alternate currents and can be stopped on either, and when no current is passing, may be employed, provided the motion be regular.

To detach the armature which controls the type wheel promptly from the electro-magnet to which it was last attracted two springs may be employed, which are of such tension that very little force is needed to repel it. The coils most distant from the armature may also be cut off, so as to concentrate the whole force of the current on the other. The inking roller is made of cloth covered with Utrecht velvet.

Fig. 1 shows a vertical section of the instrument; fig. 2 is a plan of the same; fig. 3 is an under side view; and fig. 4 shows separately some of the parts in immediate connection with the type wheels.

A is the electro-magnet for actuating the propelment; it consists of four coils; they are arranged in pairs and are so wound that when excited by the passage of a current the poles facing each other are of opposite signs. Between each pair of poles there is a soft iron tongue B; the two tongues are both mounted upon an axis C, which is built up of iron and brass, the centre portion between the tongues being of brass to prevent magnetic connection between the two tongues. The outer ends of the axis, which are of iron, pass through the extremities of the permanent horse-shoe

FIG. 1.

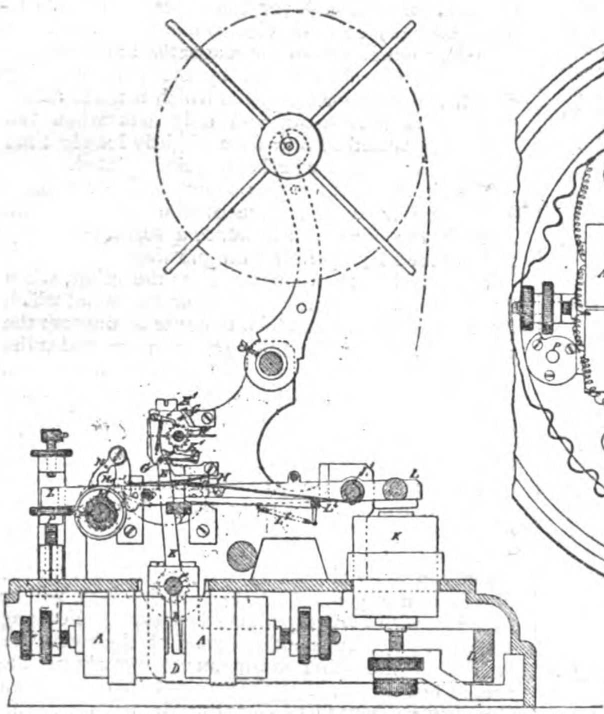


FIG. 2.

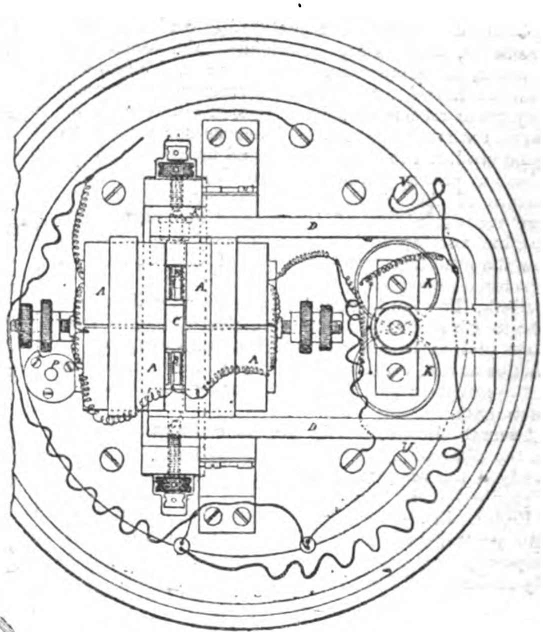


FIG. 4.

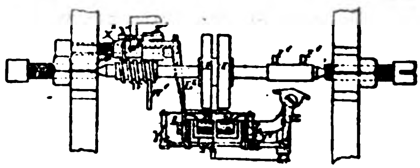


FIG. 3.

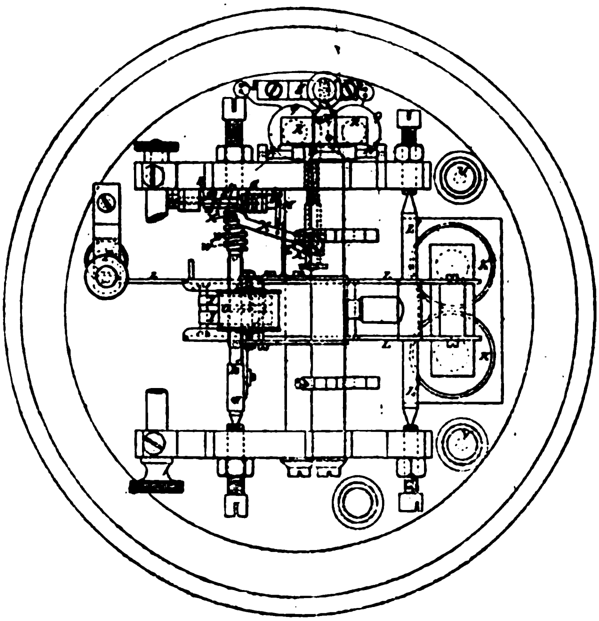


FIG. 5.

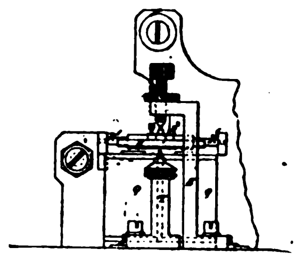


FIG. 6.

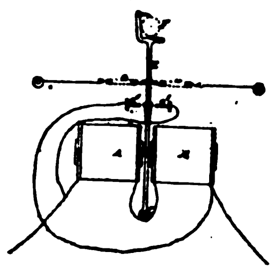
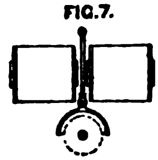


FIG. 7.



magnet D, which thus renders the tongue magnetic by induction. As before mentioned, the sending instrument is arranged to send alternate currents into the line wire, and these passing through the coils A cause each coil alternately to attract and to repel the tongue opposite to it, and so an oscillating movement is maintained for so long as it is desired to keep the type wheels in motion. Upon the axis C is fixed the propelment arm E; it carries two pawls E^1, which act upon the upper and under side of a small ratchet wheel F. These pawls are provided with springs to keep them in contact with the wheel, and screw stops are also provided upon the frame at G, which lock the pawls down at the times when the momentum imparted to the type wheels would otherwise be liable to cause them to over-run; other screw stops H, control the motion of the arm E.

I, I are the type wheels; they are upon the same axis with the ratchet F; K, K are the electro-magnetic coils, which (when they are called into action, as will be described) operate the printing lever L. This lever turns with an axis L^1, and has the armature of the magnet fixed to it. Where only one type wheel is used the printing lever simply supports at its end a pad over which and below the type wheel the strip of paper to receive the impressions is led, but where two type wheels are employed, as shown in the figure, other arrangements become requisite, which will be presently described. In either case the strip of paper after leaving the printing lever is passed over the roller M, where a nipping pawl N acts upon it. The pawl N receives its movement from an arm L^2, extending from the printing lever, and it draws the paper forward each time that the lever moves up to print. A second pawl (not shown) acts to prevent the paper moving back with the pawl N.

The types are kept constantly inked by the ink roller O, which rests lightly upon them. Stops P control the motion of the printing lever. Q, Q are the coils of the electro-magnet, which determines the direction which the current takes in its passage through the instrument; it is shown separately in elevation at fig. 5, and its operation is to put the coils K out of circuit so long as it is required that the type wheels should continue in movement; and when the printing is required to take place it places these coils in circuit and puts out the coils A, A. The magnet Q, Q is provided with an armature R pivotted at R^1, and having an arm R^2 carrying a contact spring, which when the armature is held off the magnet by its spring, makes contact with the insulated standard S, but when the armature is drawn down by the magnet through a sufficient distance this contact is broken and another contact is made with a standard T. To follow the effect of this it will be necessary to trace the connections of the instrument, commencing at the coupling screw U; the current passes to the coils Q, Q, but if, as we will suppose, the currents are of the rapidly alternating description employed to rotate the type wheels they will not cause the armature to descend sufficiently to break the upper contact. The currents then pass next through the coils A, A, then by a connection shown in fig. 3 they reach the frame of the instrument, and through this metal they are conducted to the armature R, and thence to the standard S, which is in connection with the other coupling screw V, by which the instrument is connected in circuit. When the right type has been brought round, and it is desired to print, the transmitting instrument maintains a current of one sign for a longer time, and then the armature R leaves its upper contact and completes its lower one.

Tracing as before from the coupling screw U the course of the currents is now as follows:—They first traverse the coils Q, Q, they then pass to the standard T, and so to the armature R, and to the metal of the frame, thence through the coils K, K of the printing magnet to the coupling V.

Where the circuit is long it is sometimes desirable to modify the arrangement by employing a local battery to work the printing lever, in which case the contacts for this local battery are made by means of the armature R.

The arrangement which is employed to enable the operator at the transmitting instrument to ensure that the type wheels of all the receiving instruments in circuit come to the zero point simultaneously and in unison with the transmitter, will now be described. W is a worm fixed upon the axis of the type wheels; and W^1 is a stop pin, which the axis also carries; X is a lever working upon a loose joint at X^1, and carrying a pin X^2, which by the weight of the lever and a light spring is held down so that it enters between the threads of the worm. The worm then causes the lever to move laterally, and if this movement is continued for two or three rotations of the type wheel it brings a shoulder on the end of the lever X into the path of the stop pin W^1, and when the pin comes against the shoulder the rotation of the type wheels is mechanically arrested at the zero point, and no further motion takes place, although the alternating currents may continue to be transmitted through the coils A, A. In the ordinary working of the instrument, however, before the lever X has been moved far enough to arrest the motion of the type wheel the pause for printing is made, the printing lever rises, and as it does so the projection L^2 upon it strikes up the lever X, lifting the pin X^1 out of the worm, and the spring then draws the lever and pin back to the starting point. Thus it is only when two or three complete rotations of the type wheel is made without any pause for printing that the arrangements described for setting to zero are operative.

The arrangement which determines which of the two type wheels shall print upon the paper is as follows:—The printing lever L carries two pads L^3, one for each of the type wheels; and these pads are not fixed to the lever L but upon arms pivotted to the lever at L^4; L^5 are feeble springs which sustain the pads, but allow them to yield to a light pressure, so that they are inoperative for printing unless otherwise sustained. This additional support is given to the pad which is required to print the paper (by pressing it up to the type wheel) by means of the block Y. This block is carried upon a frame Y^1 capable of sliding transversely upon the lever L, and connected by a link with the T form lever Z, the fulcrum of which is upon a bracket fixed to the printing lever; the transverse sliding of the frame Y^1 to shift the block Y from one printing pad to the other is effected by working the type wheels round until one or other of the two pins I^1 on its axis is brought to such a position beneath the axis that when the printing lever rises the head of

the lever Z is obstructed by the pin I^1, the lever Z then has to yield, and the lateral movement of the frame Y is effected.

There are blanks on the type wheels, so that no printing takes place at the time when the pins I^1 operate. One pin I^1 causes the movement of the frame Y^1 to the right hand and the other to the left. There is an interval of one step of the propelment between the pins. The frame Y^1 also carries a shield of thin and flexible sheet brass, this shield is between the paper and the type wheels. There is a slot in the shield, which permits one type wheel to print, and the other type wheel at the time of printing comes in contact with the surface of the shield, and so cannot mark the paper. The shield yields to the pressure of the type wheel, and so does the free pad L^3 immediately beneath, so that the full force of the blow is available to bring the paper into contact with the other type wheel. Sometimes for the purpose of aiding the work of the propelment two springs *e*, *e*, are connected with the propelment arm E in the manner represented in fig. 6. The springs are adjusted so that they are nearly but not quite competent to detach the tongues B, B from the magnets when no current is passing in the coils. With the same object the coils A, A on either side of the tongues are caused to be short circuited and automatically thrown out of operation as soon as the tongues recede from them so far that they cease to act with advantage. The coils remain short circuited until the tongues return within their effective range. A simple way of effecting this is shown in fig. 6. The lever E is put into metallic connection with the wire which couples the coils on the right side of the tongues with those on the left; and it also carries two contact-making springs, which, as the lever vibrates alternately, make contact with the two studs E^1, E^1, and so the connections being as the figure indicates, the coils are at the proper times shunted and their resistances eliminated from the circuit. When the circuit is long a clockwork train is employed, and in the place of a propelment an anchor escapement. To give motion to the escapement, a pin fixed in a tongue (similar to B) is caused to engage with horns on the escapement axis in the manner indicated in fig. 7, so that the play of the tongue between the poles is short as compared with that of the escapement pallets. The last wheel of the driving train, which is mounted upon the same axis with the escapement wheel, is not fixed upon the axis, but it is able to turn upon it; and there is a coiled spring connecting the wheel with the axis. This arrangement admits of the driving train running with a regular, or nearly regular, motion, whilst the movement of the escapement wheel and the type wheel in connection therewith is intermittent. In this way a higher speed of working can be attained than would be otherwise possible.

A TRIAL is being made in the central hall of the Houses of Parliament of an electric light. The machine employed to generate the current is one of Gramme's description. The whole of the plant fitted up is supplied by Messrs. Edmunson and Co.

ON THE ALTERATION OF THE THERMAL CONDUCTIVITY OF IRON AND STEEL CAUSED BY MAGNETISM.

By HERBERT TOMLINSON, B.A., Demonstrator of Natural Philosophy, King's College, London.

THE writer has, for several months, been engaged on a set of experiments devised for the determination of the alteration of the electrical and thermal conductivity of iron and steel, with the intention of determining, in absolute measure, such alteration for a given strength of current and imparted magnetism. But as, before the complete determination of the data sufficient for the purpose, a considerable time must elapse, he would venture to offer to the Society, in a preliminary note, some results which have already been obtained by him, as regards the alteration of thermal conductivity produced by magnetism.

In these experiments, the apparatus chiefly employed to impart magnetism consisted of an electro-magnet, with soft iron cores, 1 inch in diameter, and five inches in length, surrounded by cotton-covered copper wire, $\frac{1}{16}$th of an inch in diameter, having a resistance of nearly 1 ohm, and a coil constructed as follows:—a thin tube of polished tin, $1\frac{1}{4}$ inch internal diameter and $4\frac{1}{2}$ inches long, was covered with vulcanised caoutchouc to a thickness of $\frac{1}{16}$th of an inch, and on this was wound 3 lbs. of cotton-covered copper wire, $\frac{1}{30}$th of an inch diameter, followed by 3 lbs. of wire, $\frac{1}{16}$th of an inch in diameter. Inside the first tube was placed a second, 1 inch internal diameter, connected by ebonite with the first at the two ends, the second tube being concentric with the first, and of the same length, so that, between the inner tube and the outer, should be interposed a layer of air nearly $\frac{1}{8}$th of an inch in thickness. This arrangement was employed to prevent the heat from the magnetising coil reaching the bars placed inside; also, to prevent ingress or egress of heat; the bars used with the coil were covered with vulcanised caoutchouc, so that they lay with their axes coinciding with the axis of the coil.

To measure the heat conducted along the bars two sets of thermo-elements were constructed. The first was made up of two small strips of copper, $\frac{1}{2}$ inch long and $\frac{1}{4}$ inch broad, of small thickness. To these was soldered about 1 foot of silk-covered german-silver wire $\frac{1}{30}$th of an inch in diameter, the copper strips being also connected with a galvanometer by copper wires, well covered with caoutchouc, one end of each being soldered to the copper strips, so that either one or both the copper strips with the soldered German-silver wires could be employed as a thermo-element. In case it was found convenient only to employ one of these, the other was kept well covered with sawdust. These elements will be called the G. S. elements. The second set consisted of two small thermo-piles, each of twelve elements, of antimony and bismuth, and were each fitted into india-rubber tubes, so that they could be inserted into small wooden boxes, containing water, so as to fit water-tight. Sometimes these, like the G. S. elements, were used separately; at others, were made to neutralise each other's effect on the galvanometer.

To measure the current produced by these elements, a delicate Thomson's reflecting galvanometer, having a resistance of 2 ohms, was employed, the scale being placed 6 feet from the mirror of the needle.

To measure the strength of the magnetising current, a tangent galvanometer, of Gaugain's construction, was used. The needle was suspended by a very fine platinum wire, attached to a graduated torsion circle. The two thick copper wires which conveyed the current were each 27 centimetres in diameter and 14 inches apart. The needle was also provided with a mirror, so that small deflections could be read off as in a reflecting galvanometer.

A magnetometer was also employed to test the magnetism imparted, but, as the readings will not be given in this paper, no description of the instrument is necessary.

To heat one end of the bars two large Leslie's cubes were employed, having each two apertures projecting about 2 inches into the interior of the cubes. The apertures in one cube were ½ inch square and placed in one side of the cube, about 3 inches apart from each other, and half way up the side. In the other cube the apertures were circular, and ½ inch in diameter, and placed in the centres of opposite sides of the cube. Into these cubes bars of square and circular section were respectively inserted, and water filling the cubes was raised to 100° C.

The first experiment was made on a soft iron bar, ½ inch square, in section. The bar was inserted into the Leslie's cube with square aperture, filled with boiling water, and into the other aperture was inserted a brass bar of the same section. The length of the iron bar was about 10 inches, and of the brass one, 18 inches. One of the G. S. elements was fastened on to the iron bar, and the other to the brass, by caoutchouc bands, the elements being insulated from the bars by thin paper. The G. S. elements were made to very nearly counteract each others effect by sliding one or other of them up and down the bars until the heat conducted by the bars to the elements was in both the same as nearly as possible. Underneath the bar was placed the electro-magnet, with a piece of white cardboard lying on the upper extremities of the soft iron cores, so that the cores were about 3 millimetres from the iron bar; the bar was also propped by a wooden support at the other end. A preliminary experiment had been made for the purpose of ascertaining whether the heat radiated from the electro-magnet would affect the thermo elements to any appreciable extent, and this was not found to be the case.

The water in the cube was now kept boiling for about nine hours, and after that time had elapsed it was ascertained that the flow of heat from one part of the bars to another compensated the loss from radiation and the light on the scale remained stationary. (It should be observed that, as it was impossible to cause one thermo element exactly to neutralise the other, a slight use of the adjusting magnet of the galvanometer was made to bring the light near the zero of the scale.) The current from a single bichromate cell was now sent through the coil of the electro-magnet. In a few moments the spot of light began to move very slowly across the scale in a direction indicating that the flow of heat through the iron bar was being checked, and in about fifteen minutes a deflection of about 25 divisions of the scale was obtained; the current of the cell was then stopped, when the light began slowly to return, and finally settled in apparently the exact position which it held before sending the current through the coil. This experiment was repeated several times on the same day, and on several other days, but always with the same result as regards direction, namely, showing a diminution of the flow of heat from longitudinal magnetisation.

As it was thought, however, that the electro-magnet might when in action perhaps produce an apparent diminution of flow of heat by slightly disturbing the bar in its position in the aperture, though every precaution had been used to prevent the chance of this, the bar in the next set of experiments was securely soldered into the cube, and again tested as before. Here, again, some five or six trials gave the same result, and seemed to show most conclusively that the thermal conductivity of soft iron is diminished by longitudinal magnetisation.

As the method of observation, however, was tedious, and would give no idea of the amount of alteration of conductivity, other expedients were now adopted.

A piece of soft iron, which we will call B C, ½ inch long, ½ inch broad, and 2 millimetres in thickness, was soldered to two pieces of brass, A B, C D of the same breadth and thickness.

A B was 2 inches long and C D, 1 inch. The piece A B was also soldered to another piece of brass A E, having a section ½ inch square, and length about twelve inches.

The whole was placed inside a wooden box, 2 feet long, 1 foot wide, and 2 feet high, lined on the outside with tinfoil.

A E passed through a circular hole, 2 inches in diameter, in the middle of one end of the box, and through two corresponding circular holes in a double screen of sheet tin, and thence into one of the square apertures of one of the Leslie's cubes. The electro-magnet was placed underneath B C, and two pieces of soft iron, about 3½ inches in length, ½ inch in breadth, and about 2 millimetres in thickness, were placed on the ends of the soft iron cores, so as to be on the same level with B C, and distant from B and C about 2 millimetres, the pieces of iron being separated from the cores by a piece of white paper. In some experiments the pieces of iron thus used were carefully secured to the electro-magnet by elastic straps, and, in others, by weights placed on them. A preliminary experiment, made with the strongest current that was ultimately used with the electro-magnet, showed that neither were the iron pieces on the cores appreciably shifted on magnetising the coil, nor was the heat radiated from the coil sufficient to produce any effect on one of the G. S. elements fastened by elastic bands to the back of C D. The other G. S. element was in this case buried in sawdust, with which the box was now filled, so as to cover completely the bars and electro-magnet. The sawdust also filled the space between A B and C D, and the small portion of the brass bar A E, which was between the box and the Leslie cube, was covered with caoutchouc and cotton wool.

The lid of the box was now put on, and some time

allowed to elapse until the light remained steady on the scale.

Boiling water was then put into the cube, and a burner placed underneath. Very shortly the light began to move across the scale, showing that the heat had been conducted along the compound bar to the thermo element, and that the number of divisions on the scale passed over by the light was taken for each minute. The adjusting magnet of the galvanometer had in these and similar experiments to be placed very low down in order that the number of divisions of the scale passed over might not exceed 60 per minute. When the light reached one end of the scale the adjusting magnet was used to bring it back again to the other. In these and similar experiments it was found that, after some time, either the number of divisions passed over per minute increased or diminished very slowly or else remained constant for some minutes. The following observations were made with the specimen in question, the light being near one end of the scale. The number of divisions passed over in consecutive minutes was as follows (the magnetising current will be called M. C.) :—

A M.C. not flowing	B M.C. flowing.	C. M.C. not flowing	D M.C. flowing.
1st min. 40	1st min. 34	1st min. 31	1st min. 28
2nd min. 39	2nd min. 34	2nd min. 33	2nd min. 29
3rd „ 38	3rd „ 33	3rd „ 31	3rd „ 27
4th „ 34	4th „ 31	4th „ 31	4th „ 29
5th „ 36	5th „ 32	5th „ 30	5th „ 28
No. of divisions in last 4 min. = 147	No. of divisions in last 4 min. = 130.	No. of divisions in last 4 min. = 125.	No. of divisions in last 4 min. = 113.

The light was then near the other end of the scale, so the adjusting magnet was employed to bring the light back again. The set of experiments here given, the first of many, is rather an unfavourable one, most of them giving results much closer together than those here given, and in several instances the flow of heat would seem perfectly steady for upwards of fifteen minutes.

The observations of the first minute in each case were not taken, in order to avoid error from very slight deviations of the galvanometer needles caused by the action of the electro-magnet, which, however, was placed at such a distance from the galvanometer, and in such a position as not, in most cases, to produce any such deflection, and to give time for the magnetism to produce its effect on the bar. It has been determined that in experiments made in this manner, 1 minute seems quite sufficient for the above-mentioned purpose.

Taking A and C together, we obtain as a mean 136 divisions passed over in four minutes with the M. C. flowing, as against 130 from B with the current flowing; again, from B and D, with the current flowing, we obtained 121·5 as against 125, with the current not flowing, so that, in both cases, there is a less mean flow with the M. C. flowing than when it is not flowing. The mean of this particular set of experiments would give a decrease of flow, when the bar is magnetised longitudinally, of about 3·6 per cent of the whole for a magnetising current, causing a deflection of the needle of the galvanometer of 18·6°. The mean of all the observations for the specimen, and for this current, gave a decrease of flow amounting to 3·3 per cent. of the whole.

The electro-magnet was now turned through 90°, so as to magnetise the iron transversely, and a similar set of experiments were made.

Here, again, the result was most conclusive, and the mean of several observations showed an *increase* of flow when the bar was magnetised transversely, amounting to about 3·2 per cent. of the whole for the same current strength.

Thus, the decrease of conductivity in one case seems roughly to be equal to the increase in the other, but it is the intention of the author to make further researches into this part of the inquiry.

The batteries employed in these and subsequent experiments were slight modifications of Daniell's batteries, which, though having a very small resistance, maintained a constant current for some hours. These batteries the writer hopes to have the honour of describing to the Society on a future occasion.

Similar experiments were next made on a piece of hard steel, of similar dimensions to those of the iron, but the length of the brass bar, A E, was considerably shortened.

The result of the experiments proved that there was a decrease of flow, amounting to about four per cent., of the whole, when the bar was magnetised longitudinally with a current producing a deflection of 18° on the tangent galvanometer, and an increase of flow when magnetised by a current of 10° C. transversely, amounting to about three per cent. of the whole (unfortunately, through accident at the time, the same magnetising current as used for longitudinal magnetisation could not be employed).

This last result was rather unexpected, as, though Sir William Thomson has shown (Phil. Trans., Feb. 28, 1856) that the electric conductivity of hard steel is diminished when the steel is magnetised longitudinally, some experiments of the writer in the same direction (Proc. of Royal Society, June 17, 1875) seemed to show that, in the case of hard steel, the contrary effect is produced, while Joule has proved (Phil. Mag., 1847) that, while a bar of iron, or even steel which is so hard that a file will just touch it, is lengthened by longitudinal magnetisation, that iron, under great strain, or steel so hard that a file will not touch it, is shortened.

Of course, the mere act of soldering the steel to the brass would, to a certain extent, soften the steel.

In order, therefore, to avoid soldering, a bar of steel of circular section, ½ inch in diameter and about 12 inches in length, was made so hard that it could not be touched with a file, and placed, with the usual precautions, on the poles of the electro-magnet, at a height of about 3 millimetres above the cores of the electro-magnet, one of the G. S. elements being secured to one end and the other end inserted in a Leslie's cube. But here, again, there was undoubtedly a decrease of conductivity, when the bar was magnetised longitudinally. Of course, however, the mere fact of heating the bar at one end to the temperature of boiling water would tend to soften the bar, and the writer is not quite satisfied but that it may be ascertained that, for low temperatures, the conductivity of hard steel is increased. It is intended, therefore, to make experiments on iron and steel, at different temperatures,

both high and low, with a view of definitely settling this point.

Some experiments were next made with the magnetising coil described in the beginning of the paper, but the effects produced were found to be so much less for the hard steel than when the electro-magnet was employed that it was found necessary to use the thermo-piles, also mentioned above, and instead of employing the compensating magnet to bring the light on to the scale to cause the two piles, as much as possible, to neutralise each other's effects. Accordingly the following arrangements were made:

Two bars of hard steel, each $3\frac{1}{2}$ inches long and $\frac{1}{4}$ inch in diameter, were soldered at each end to two copper rods, each about $4\frac{1}{2}$ inches in length and $\frac{1}{4}$ inch in diameter. One copper terminal of each rod was inserted into a Leslie's cube, filled with water kept at the boiling point by means of a burner to a distance of 2 inches, and the other terminal into a small wooden box, varnished inside with shell-lac, and capable of containing about 120 cubic centimetres of water. The bars were well covered with caoutchouc; and double screens and two thermo elements were so arranged as to send their currents through the galvanometer in opposite directions, the wires connecting them with each other and the galvanometer being well covered with gutta-percha, and passing through small holes in the sides of the boxes. The two compound bars were thus made as exactly similar as possible, and also similarly placed, the only difference being that produced by the magnetising coil, whose axis coincided with that of the steel bar placed inside it.

Both the small boxes had originally the same quantity of water placed in them, and a previous experiment had shown that so exactly similar was the heat conducted along the bars to the water in the boxes, that when some two hours or so had elapsed, the rise of temperature of the water in each box seemed as measured by an ordinary thermometer, marked off in degrees centrigade, to be exactly the same, namely, 10° C.

But as the same experiment had shown that the pile in one of the boxes was very slightly more powerful than the other, the water in the other box was diminished very carefully by means of a small siphon, formed of india-rubber tubing, of very small bore, which was kept closed by a pinch-cock at one end, the tube passing through holes cut in the large box, through the sawdust, and through a small hole cut in the lid of the small box, so as to dip into the water. The little siphon was always kept charged, and, by means of the pinch-cock, any desired small quantity of water could be extracted from the box.

By this means it was found easy to make one pile so neutralise the other that a very slight use (if any is necessary) of the adjusting magnet was required, even when the magnet was near its most sensitive position with respect to the galvanometer needle.

On sending a current through a coil around the steel bar, it was in a minute or so seen that the conductivity of the hard steel was diminished by the longitudinal magnetisation, and the amount of diminution was roughly determined by finding the amount of water necessary to be extracted from the box to again bring the light to the same slow rate of motion (about two divisions per minute) which it had before passing the magnetising current, and comparing this with the original amount of water in the box. The decrease of flow did not amount to 1 per cent. of the whole, even with the strongest battery used (current shown by the tangent galvanometer, 26°).

This plan was found to be highly successful for determining whether there was a diminution or not, but not equally so for determining the amount of decrease, owing to the great difficulty in this method of quickly making the light move at the same rate after magnetisation as before. Another method was therefore tried, which promises to give better results.

The two piles, P_1 and P_2 were joined up with the galvanometer and a shunt S, so as to obtain equilibrium, according to Poggendorff's method of comparing the electro-motive forces of batteries.

The same quantity of water was now put into each box, and the pile P_1 being slightly more powerful than P_2, the shunt S was adjusted until there was little or no motion of the light on the scale.

The magnetising current was then passed through the coil, and the shunt again adjusted, until the piles neutralised each other.

It can be shown that if x_1, x_2 be the units of heat imparted to the water in the two boxes in the same time, $\frac{x_2}{x_1} = \frac{S}{R + S}$ when the piles neutralise each other, where R is the resistance of the portion of the circuit in which P_1 is placed.

If, then, dx_2 be the diminution of flow caused by magnetisation, and dS the diminution of shunt resistance necessary to again make one pile neutralise the other,

$$\frac{x_2 - dx_2}{x_1} = \frac{S - dS}{R + S - dS}$$

$$\therefore \frac{dx_2}{x_2} = \frac{R \times dS}{S(R + S - dS)}$$

and thus the per centage of diminution of flow may be determined.

A few resistance coils were very roughly constructed for use in the shunt S, and an attempt made to ascertain the actual amount of diminution of conductivity of the hard steel. This, again, appeared to be comparatively small, but as the coils used were not suitable for the purpose, the result is not given. But the writer has little reason to doubt but that, with resistance coils suitable for such thermo-electric experiments, he will be able to measure, with fair accuracy, small variations of thermal conductivity in this way.

It should be added that similar experiments to these were made with soft iron bars, both with and without copper terminals, but the results of the experiments, of which altogether upwards of a hundred have now been made, show that in every case the thermal conductivity of soft iron is diminished by temporary longitudinal magnetisation, and increased by transverse magnetisation, whilst in the case of steel, of different degrees of hardness, at any rate, for the temperatures employed, magnetisation evidently produces the same kind of effect as with the soft iron. The amount of the alteration in the case of soft iron must have reached

at least as high as 10 per cent., and may be greater. The experiments which the writer has made on electrical conductivity have shown that this is also very appreciably altered by magnetism, at least 6 per cent., even when the magnetisation was evidently not complete (Proc. of R. S., June 17, 1875), and has some reasons for believing that the amount of alteration for thermal and electrical conductivity will be found to be not very different. He hopes, however, to thoroughly investigate the whole subject.

It should be mentioned here that Sir William Thomson (Phil. Trans., Feb. 28, 1856) expresses a strong opinion that the experiments of Dr. Maggi on this subject, on which he says doubts have been thrown by others, would be found correct, basing his opinion on the results of his own experiments on the alteration of electrical conductivity by magnetism. And, though the writer had some years ago made some attempts in the present direction (unfortunately before perusing Sir William Thomson's exceedingly valuable paper), he cannot conclude without expressing how greatly the suggestions there thrown out have assisted him in these and other experiments.—*Proceedings of the Royal Society.*

TELEGRAPH POSTS IN JAVA.

The supports used for carrying the system of telegraph wires through the Island of Java merit a short description.

These are formed of the trunk of a tree known as the "Kapas" tree, which derives its name from a species of short fibred cotton which it produces. This tree possesses the two following advantages, which fit it admirably for the purpose. In the first place, when a tree is cut down, and the upper or branched part cut away, it possesses such an amount of vitality, that when placed in the ground it will at once form new roots and branches, thus effectually protecting it from the ravages of the white ants who would soon make very short work of an ordinary telegraph post. Secondly, the branches always spreading out horizontally never come in contact with the wires or insulators.

Another advantage lies in their elegant appearance as contrasted with a similar number of bare poles.

When once planted, probably no further attention would be necessary, and unless blown down by a gale (which their form would render unlikely) or damaged by lightning, they would last for very many years.

PHOTOGRAPHING FROM BALLOONS.

Mr. W. B. Woodbury has conceived the ingenious idea of elevating a photographic apparatus in a balloon, and manipulating it there, from *terra firma*, by means of electricity, so that a picture of the country underneath may be obtained without any of those personal risks which still attend the ascent of the aeronaut. It will be at once obvious that Mr. Woodbury's plan might prove useful in military operations. In times of war it would be possible in this way for a besieging army to obtain a photograph of the fortifications it was bent upon attacking, or for a beleaguered city to get a bird's eye view of the surrounding country, comprising the camps and entrenchments of the enemy. The balloon is, of course, held captive by a rope or cable, along which the electrical wires are laid. In the position ordinarily occupied by the car, a box, open at the bottom, is attached. To one side of this box the cable is connected, and to the other is fixed a species of sail or rudder designed to keep the balloon from turning round. Inside this box-car a second box is swung on a pivot, so that it may keep horizontal. This inner box contains the necessary photographic apparatus, consisting of the lens which is placed in the bottom, a dark slide having two rollers carrying the sensitive tissue, moved by clockwork, and an electro-magnetic arrangement for guiding its movements and likewise working an instantaneous shutter placed immediately over the lens. The clockwork is set in motion and also arrested at will by electric communication with the earth, thus exposing a fresh length of the sensitive paper as required. The shutter is a dish of ebonite or metal having an aperture at one side, and is made to revolve rapidly in front of the lens every time it is released by a catch acted on by an electro-magnet excited from the earth. The circuit for controlling the clockwork, and that for working the shutter, involve three wires of communication. When the balloon is elevated to the required height, the lens properly focussed, and the tissue in position, the shutter is set in motion by the current giving instantaneous exposure. A photograph is thus obtained; and by further controlling the clockwork, fresh sensitised surface may be exposed, and additional images taken. This arrangement has been patented by Mr. Woodbury.—Patent No. 1647, year, 1877.

EARTH CURRENTS.

By Chr. DRESING, of the Great Northern Telegraph Company.

Hoping to obtain some few additional facts to our present unsatisfactory knowledge of earth currents, I and Mr. Terp, the company's superintendent, a couple of years ago commenced a series of observations of earth currents on the Scotch-Norwegian Cable. The line being a busy one, was only occasionally (and especially on account of an interruption of the Norwegian and Scottish lines) at our disposal, and though the observations in consequence could not be carried out as frequently as could be desired, the following table, *which is a fair specimen of all the observations,* will be sufficient to demonstrate a certain regularity in the *diurnal variations* of the *strength* and *direction* of the natural current.

I may remark, that the deflections noted are readings from the scale of an *ordinary,* but sensitive *detector* of a resistance of about 1,200 ohms, and the

strengths of the current and the deflections are not directly proportional to one another.

Date.	Time.	Deflection. +	Deflection. —	Remarks.	Weather.
Jan. 1	8 0 a.m	..	33	Steady deflection -	N.E. breeze [fine.
—	9 40	0	0	Changing direction	
—	10 40	65	..	Steady - - - -	
—	12 40 p.m	63	..	*i.e.*, equal to 4 Leclanche's cells -	
—	2 0	60	..	Steady - - - - -	
—	3 10	54	..	,, - - - - -	
—	3 40	47	..	,, - - - - -	
—	4 30	15	..	,, - - - - -	
—	4 50	0	0	Changing direction	
—	5 0	..	10	Steady - - - - -	
—	5 30	..	30	,, - - - - -	
—	6 0	..	45	....	
—	6 30	..	50	Steady; increasing	
—	6 45	..	53	....	
—	7 30	..	55	....	
—	8 35	..	50	Steady; decreasing	
—	9 46	..	10 to 35	Swinging - - - -	
—	10 15	..	..	Changing direction	
—	10 50	40	..	Steady; slowly increasing - - -	
Jan. 2	12 0 a.m	48	..	....	
—	1 15	50	..	....	
—	7 50	..	86(?)	Steady - - - -	Fine; frosty.
—	8 25	..	55	....	
—	8 50	..	52	Unsteady - - - -	
—	9 45	..	42	Steady; decreasing	
—	10 0	..	..	Unsteady; swinging across zero - -	
—	12 0 noon	45	..	Unsteady - - - -	
—	1 0 p.m	59	..	Steady - - - - -	
—	1 46	58	..	,, - - - - -	
—	2 25	59	..	,, - - - - -	
—	3 38	48	..	,, - - - - -	
—	4 0	12	..	,, - - - - -	
—	5 0	..	..	Changing direction	
—	5 35	..	25	Constantly increasing	
—	6 57	..	55	,, ,,	
—	8 57	..	58	Steady - - - - -	
Jan. 3	8 40 a.m	..	55	....	Fine weather; [frosty.
—	10 0	..	45	Steady; decreasing	
—	11 15	..	..	Changing direction	
—	11 30	25	..	....	
—	1 15 p.m	53	..	....	
—	2 47	58	..	....	
—	3 45	56	..	....	
—	5 50	30	..	Rapidly increasing	
—	6 0	..	..	Changing direction	
—	6 30	..	8	Steady; increasing	
—	8 30	..	60	Steady - - - - -	
—	10 5	..	59	Decreasing - - -	
Jan. 4	12 32 a.m	..	..	Swinging across zero - - - - -	N.E. gale.
—	8 15	..	45	Steady - - - - -	
—	11 20	..	13	Rapidly falling - -	
—	11 57	..	..	Changing direction, gradually assuming positive tendency -	
—	12 52	30	..	....	
—	1 50	45	..	Variable - - - -	
—	2 38	45	..	,, - - - -	
—	4 2 p m	50	..	,, - - - -	
—	6 20	39	..	Steady - - - - -	
—	7 7	27	..	,, - - - - -	
—	7 15	16	..	,, - - - - -	
—	7 36	..	..	Changing direction	
—	7 45	..	15	....	
—	8 45	..	34	Steady - - - - -	
—	10 55	..	43	,, - - - - -	
—	11 40	..	42	,, - - - - -	
Jan. 5	7 30 a.m	15	..	....	N.E. gale.
—	8 0	..	..	Changing direction	
—	9 40	..	30	Variable - - - -	
—	10 20	+ 20 to — 40		Very variable - -	
—	11 30	..	30	Steady - - - - -	
—	12 45 p.m	+ 30 to — 30		Very variable - -	
—	12 58	..	5	....	
—	1 30	..	..	Changing - - - -	
—	1 50	15	..	....	
—	3 0	34	..	....	
—	3 40	40	..	Variable - - - -	
—	4 10	43	..	Steady - - - - -	
—	4 45	45	..	....	
—	6 15	38	..	Decreasing - - -	
—	8 0	..	..	Changing direction	
—	8 15	..	9	....	
—	10 17	..	48	....	
—	11 15	..	55	....	
Jan. 6	1 0 a.m	..	50	Decreasing again -	

From this table and from all my numerous observations, which have tended to confirm the above results, without however, throwing any new light on the subject, the following conclusions may be derived :—

1st.—That there is always a natural current flowing through the cable.

2nd.—That this current is sometimes flowing from Scotland to Norway, sometimes in the opposite direction.

3rd.—That the current after each change of direction increases gradually, from a minimum to a certain maximum strength, and then again decreases until, after passing the zero-point, which only occupies about a minute, it assumes an opposite direction.

4th.—That the change of direction takes place about every six hours, *i.e.*, 4 times in the 24 hours.

5th.—That the *normal maximum strength* of the *natural current*—as proved by proper measurement—scarcely ever exceeds 3 to 4 Léclanché's cells.

6th.—That great *meteorological* disturbances *usually* are preceded, accompanied, or followed, by similar *electric* disturbances in the cable.

EFFECTS OF ELECTRIC CURRENTS OF HIGH TENSION.

FOLLOWING up a series of former notices, M. Tissandier, in *La Nature*, gives an account of some of the recent experiments of the eminent French physicist, M. Gaston Planté, with his large battery of secondary elements. This battery consists of 800 pairs, and is arranged in sets of 40 pairs each.

Before commencing work, the pairs are joined up for "quantity" by means of commutators, and are then charged or polarised from a few Bunsen cells. When the battery has not been long unused, a few hours suffice for the charging. By turning the commutators, the battery can then be arranged for "tension" and discharged at pleasure, either immediately, or after some time.

The experiments are usually conducted in a darkened room, in order to study the luminous phenomena produced.

Electro-silicic light.—If a platinum wire, passed through a small glass tube, be immersed in a solution of potassium nitrate, and connected with one of the poles of a secondary battery of 60 couples, an electrode from the other pole being previously immersed, the lower end of the tube is fused within the liquid and gives out a dazzling light (fig. 1). The end of the platinum wire is found to be sealed into a small globular mass of fused glass, and the light is vividly maintained until the cooling of the glass insulates the wire from the liquid. When a solution of sea-salt is used, from 250 to 300 couples are required to produce a similar effect. The manner in which saline solutions behave, in presence of the silica in the glass raised to high temperature by the passage of the current, is, in fact, very varied, in consequence of the greater or lesser fusibility of the silicates formed, a fact already recognised by M. Carré in combining various salts with the carbons employed to produce the ordinary electric light.

This vitreous light may also be caused by bringing either of the electrodes near a plate of glass at a little distance below the surface of a saline solution

fig. 2). In this case the light is accompanied by the giving off of white vapours, the glass being at the same time strongly attacked. The light may also be produced at the edge of a porcelain dish, and is then comparable with that of the voltaic arc in M. Jablochkoff's electric candles.

The luminous phenomena observed with glass, by means of induction currents, by MM. du Moncel, Gassiot, Grove, &c., may likewise be compared with that treated of here.

One might be led to attribute the brilliancy of this light to the lime combined with the silica in glass, but an examination of the spectrum it gives shows no appreciable lines, whilst a fragment of

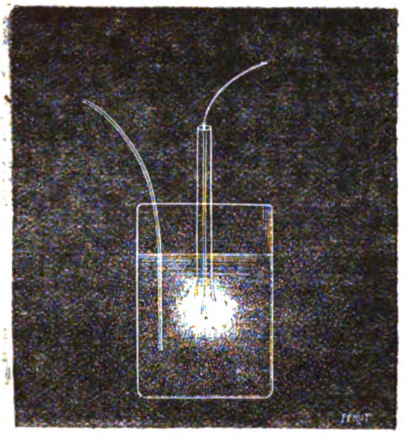


FIG. 1.

calcareous spa, subjected to the same conditions, not only gives a vivid light, but also shows the characteristic lines of calcium.

The lines of silicon being feeble, according to M. Kirchoff's analysis, it is conceivable that they should not be detected, by reason of the intensity of the spectrum formed; but the *silicic* origin of this light

FIG. 2.

is proved by the important fact that it is reproduced with pure silica in the form of transparent quartz crystals (fig. 3). It is only necessary, in this case, to employ, with the same saline solution, a somewhat greater force, say 100 secondary couples. The silica itself being decomposed by these currents of high tension, the luminous effect results, according to all appearance, from the incandescent silicon, analagous effects to which have been shown by MM. Sainte-Claire Deville and Wöhler with diamond and graphite. To distinguish the light observed by him from that obtained with carbon points, M. Planté has given to it the name of *electro-silicic* light.

Etching on Glass.—In a series of analogous experiments, M. Planté noticed that the luminous veins or rings formed round the positive electrode of a powerful battery remained sometimes graven on the surface of the glass voltameter containing a saline solution, and this observation led him to apply the electric current to etching on glass or crystal. The surface of the plate of glass or crystal is covered with a concentrated solution of potassium nitrate by simply pouring the liquid over it in a shallow vessel. A platinum wire is laid round the object, within the liquid, and is connected with one pole of secondary battery of 50 or 60

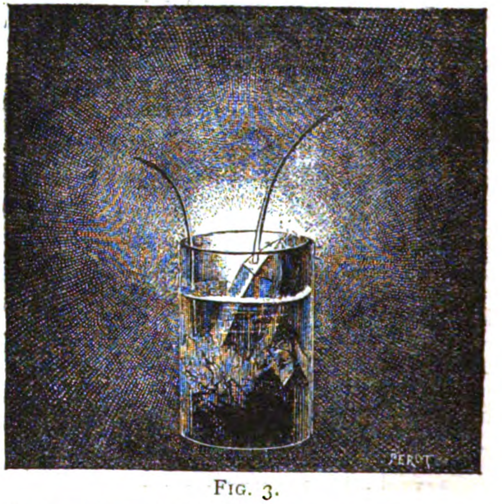


FIG. 3.

pairs; another platinum wire insulated, except at its extremity, is taken in the hand and the required design traced out on the surface of the glass or crystal. A luminous furrow is produced wherever the wire touches, and whatever the speed with which the writing or design is traced out, the track is left neatly engraved upon the surface. If the speed is slow, the track is deep; its width is dependent upon the diameter of the platinum electrode; if this be drawn to a point, the writing may be made very delicate. The wire conveying the current becomes thus a specially adapted graver for glass, and, in spite of the hardness of the surface to be cut into, requires no special effort on the part of the operator, for it is only necessary to pass the wire lightly over the surface to obtain an ineffaceable engraving. The corroding force is furnished by the action, at once thermic and chemical, of the electric current in presence of a saline solution.*

* The figures produced on glass by static electricity and the impressions obtained by Mr. Grove with induced currents, are comparable with these effects produced on glass by dynamic electricity. But as the quantity of electricity

Although these results have been obtained with the aid of a "secondary" battery, M. Planté states that for continuous work any other source of electricity of sufficient quantity and tension may be employed, whether a Bunsen battery or a Gramme machine, or even a magneto-electric machine giving alternate currents.

This novel application of electricity appears fitted to be of service in the glass industry, and to offer some advantages over the unhealthy methods at present in use.

BECQUEREL.

We are now able to give a likeness of Antoine Cesar Becquerel, the illustrious French physicist and electrician, lately deceased. Becquerel died on January 18th, at the advanced age of ninety years. A full account of his life and works is to be found

in the Telegraphic Journal for Feb. 15th. His scientific labours extended over a wide field, but his fame chiefly rests on his electro-chemical discoveries. His son, Edmond Becquerel, is worthily pursuing his father's favourite lines of research. We are indebted for the portrait to *La Nature*.

THE POSTAL TELEGRAPH DEPARTMENT.

The estimates for the financial year commencing April 1st, 1878, which have lately been published, show that the Engineering Department of the Postal Telegraph Service, has undergone a reorganisation. Under the new constitution the following will be the principal strength of the force :—

Engineer-in-Chief's Office.

1 Engineer-in-Chief.
1 Assistant Engineer and Electrician.
1 Submarine Superintendent.
1 Assistant do.
4 Superintending Clerks.

Controller of Stores Office.

1 Controller of Stores.
2 Superintending Clerks.

Metropolitan and Provincial Force.

1 Divisional Engineer (Ireland).
1 Superintending Engineer (London).
4 Superintending Engineers, 1st Class.
10 " " 2nd "
2 Inspectors, Senior (London).
20 " 1st Class.
41 " 2nd "

Royal Engineers

2 Superintending Engineers
3 " " 2nd Class.
4 Inspectors, 1st Class.
5 " 2nd "

Factories

1 Superintendent.
1 Assistant do.
1 Inspector.
1 Foreman of Mechanics.

Telegraph Instruction.

1 Superintendent.
1 Assistant.

THE PHONOGRAPH AND VOWEL SOUNDS.

It has been pointed out by Professor Fleeming Jenkin, and Mr. J. A. Ewing, in a letter to *Nature*, that whereas rotating the barrel of the talking phonograph at different speeds gives corresponding differences of pitch in the sounds, it does not alter their quality. This result appears to disagree with Helmholtz's theory that the characteristic quality of each vowel is given by the predominance of a constituent note of definite pitch in the sounds uttered. For the absolute pitches of the constituents of the vowel sounds in the experiments in question were all altered in the same proportion, so that the absolute pitches of the predominant notes varied greatly; yet the vowel quality was unchanged. Another fact has been elicited in these experiments, namely, that if a scale be sung into the phonograph with one vowel sound, such as O, the wave-form of the marks on the tinfoil does not remain unchanged at all pitches.

The late severe snowstorms and gale have caused serious interruptions to the telegraphic communication in various parts of the country, and especially in the West of England and South Wales.

furnished by electrical machines or induction coils is, relatively, very small, and as there is also no electro-chemical effect such as is here produced in presence of a saline solution, these figures and impressions are very indistinct. To be seen they require a deposit of dew or the moisture produced by breathing, for which reason they have been named "figures roriques" (*ros, roris, dew*) by MM. Reiss, Peyré, Wartmann, &c.

Notes.

TELEPHONIANA.—In a paper recently read before the King's College Engineering Society, Mr. C. W. Cunningham compared the vibrating plate with the tympanic membrane of the ear, and pointed out that the predominance of the fundamental note of a flat plate will drown a large number of the overtones of the voice, and thus cause the observed peculiarity of the telephonic voice. The tympanic membrane, on the contrary, being of a funnel shape, is peculiarly susceptible to the influence of sound, and has no fundamental note of its own. It, therefore, transmits all audible sounds to the aural nerves without giving undue preponderance to any particular one.

IT is reported from Titusville, Pennsylvania, U.S., that the telephone will convey audible speech if it be applied to any part of the body of the speaker instead of to his lips. The sounds are fainter by this mode of operating, but quite distinct. A person may, therefore, transmit what he is saying by merely pressing a pocket telephone against his body.

IT has been suggested in America to apply the telephone to railway trains as a means of communication between driver and guard.

THE time occupied by a projectile in traversing its range is usually estimated by observing the flash and the moment of its fall to earth. In places where the flash cannot be observed the detonation may be as quickly heard by telephone.

IT is said that the Chinese are particularly well pleased with the telephone, and that messages have been sent in China over 500 miles of wire.

FROM a consideration of the recently observed facts that the telephone acts when the diaphragm of the receiving instrument is not only very thick and massive, but when it is non-magnetic, and even when there is no diaphragm at all, M. du Moncel argues that the articulate vibrations are principally produced in the magnetic bar itself, as the sounds were produced in the needle of Page's experiment. If this be true, the vibrating plate of the receiving telephone only strengthens, by reaction on the pole of the magnet, the magnetic effects determined in the interior of the latter by the undulatory current coming from the sending telephone. A diaphragm on the sending telephone is of course necessary to originate these currents under the influence of the voice. The lightness and flexibility of the receiving diaphragm are advantageous, because the magnetic variations due to the undulatory current will take place more rapidly in a plate of small mass, and the vibrations are for the same note of greater amplitude in a more flexible plate. In the sending telephone greater amplitude of vibration is attended by greater intensity of the induced currents transmitted; and in the receiving telephone the variations of magnetisation determining the sounds are rendered more sharp and definite; in both cases, therefore, there is an advantage in using a light flexible plate. As to the cause of the sounds emitted by the magnetic core, M. du Moncel thinks that they appear to be due to dilatations and contractions of the magnetic molecules, under the influence of successive magnetisations and demagnetisations.

MR. WM. F. CHANNING, in a letter to the *Journal of the Telegraph* (America), states that any common magneto-electric machine, arranged for giving shocks, makes an excellent telephone call—the sounds heard in a distant telephone having something of the character of a watchman's rattle, and being loud enough to be heard through adjoining rooms.

A COURSE of six lectures on electric telephony, by Mr. W. J. Wilson, F.C.S., M.S.T.E., will be delivered at the Birkbeck Literary and Scientific Institution, on Saturday evenings, commencing March 23. The syllabus includes an exposition of the elementary electrical apparatus involved; the mechanism of the ear; the nature of sound; phonographs, including Edison's; and the different kinds of telephones. The entire proceeds of these lectures will be given to the fund now being raised for the erection of a new building for the institution.

WE are told that Mr. Edison has constructed a clock which calls out the hours by phonograph, and adds appropriate remarks. The days of the cuckoo clocks are therefore numbered, if, indeed, they have not been so for a good many years, for we may now have clocks which will mimic any sounds whatever. The appropriate remarks which a clock might make are obviously of a very varied kind. The time-worn motto "*Tempus fugit*" would receive a new emphasis by being spoken to us, but we fear it would be as little heeded as before, although delivered in the most impressive and solemn manner. Then we might have "Go to the ant thou sluggard" ejaculated at a sufficiently early hour in the morning, and "Early to bed," &c., just suggested to us at bed-time, as well as many other wise saws and copy-book morals. There would be some danger, however, of a pragmatical clock of this kind becoming a bore, unless its observations were both varied and amusing; but this they could easily be. How convenient such a clock will be for society to administer its delicate hints to unwelcome visitors!

CRYSTALLISED MUSIC.—Not seldom have the poet lightly scattered from their teeming fancy, ideas which

later ages of science have slowly made good in fact. In Shelley's *Witch of Atlas* occur the following lines:—

The deep recesses of her odorous dwelling
Were stored with magic treasures, sounds of air,
Which had the power all spirits of compelling,
Folded in cells of crystal silence there,
Such as we hear in youth, and think the feeling
Will never die—yet ere we are aware,
The feeling and the sound are fled and gone,
And the regret they leave remains alone.

Of course this poetic dream has been realised by the phonograph of Edison, who, happily, need not fear any claim of priority of invention on the part of the *Witch of Atlas.*

THE American "Keats" lock-stitch sewing machine, a new invention, is said to be able to sew through all kinds of sole leather and belting, and also to stitch leather to pine boarding.

LOCAL ELECTRICAL SOCIETIES are spreading in the United States. After the American Electrical Society which is representative of the whole country, there is the Chicago Electrical Society, now a large and flourishing body, and more recently in the cities of San Francisco, Cal., and in Cleveland and Toledo, Ohio, there have been started three other local societies. The members diversify the severer scientific business of the meetings by songs, music, and recitations. This evidence of a healthy *esprit de corps* amongst American electricians is quite refreshing.

A FREAK OF TELEGRAPHY.—On March 2, Reuter's Agency received the following telegram from Brisbane, Australia :—"Governor of Queensland, twins first son." Their official at once interpreted this into conventional English, and it appeared in the leading newspapers next morning as "Lady Kennedy has given birth to twins, the eldest being a son." This announcement was well calculated to surprise the friends of Sir Arthur Kennedy in England, who had reason to believe that he was unmarried, and on their suggesting to Reuter's that there must be some mistake, a repetition of the message was asked for. It was received a few days later, and ran thus :—"Governor of Queensland turns first sod." It appears that Governor Kennedy had been opening the works of the Maryborough-Gympic Railway.

THE steamers *John Pender* and *Chiltern*, left Malta, on Wednesday, March 13, with submarine cables on board, having been chartered by the Government to lay them at various points in the Levant.

TELEGRAPHIC COMMUNICATION WITH THE CAPE.—A meeting of South African merchants was held recently in the City, and resolutions were passed in favour of the establishment of a telegraph line to Cape Colony. Mr. Donald Currie occupied the chair. A committee was appointed to represent the views of the colonists to Sir Michael Hicks-Beach, and to press upon the Government the urgent necessity for the early laying of a line of cable to connect England and South Africa, leaving it to the Government to judge whether the cable should be laid on the east or west side of Africa.

THE Post Office authorities notify that the cable between England and France and the Channel Islands is interrupted. The English cable also being interrupted, messages can now only be despatched by steamer.

A DEAF-MUTE TELEGRAPHER. — Considering the fact that in telegraphy, as now practised, all messages are read from sound, and that on the quickness and good training of the ear depends, to a great extent, an operator's skill, one of the most remarkable cases (in fact the only one) on record in this or any other country was that of the late Samuel J. Hoffman. Having lost his hearing entirely a short time after learning telegraphy, he nevertheless continued the practice and successively occupied prominent positions as long as he lived. He made use of a sounder of his own construction, and received by placing his hand over it in such a manner that he could feel distinctly every vibration of the armature. He could thus continue to receive by the hour without "breaking," and experienced no difficulty except when the wire worked hard, or the circuit changed frequently; he obviated this by placing his fingers on the binding screws of the relay, distinguishing the characters by variations of the current. He died in Florida, having gained the reputation of being a most thorough operator and electrician.—*Scientific American.*

AN attempt is being made by a party in the Western Union Telegraph Company of America to obtain a repeal of the agreement entered into in August last between that Company and its great rival the Atlantic and Pacific Company to "pool" their joint receipts, the A. and P. getting 12½ per cent., and the W. U. the remainder. It appears that the latter company finds the expenditure of the A. and P. to be largely in excess of its receipts, so that under terms of its agreement the W. U. was obliged in the first three months of the amalgamation to pay out to the A. and P. an aggregate of 120,000 dollars. Application has been made by Elias C. Benedict (who claims to own a hundred shares of W. U. stock, and is known as a warm partisan of that company) and other shareholders for a perpetual injunction, restraining the W. U. from carrying out the provisions of their recent agreement with the A. and P. This was granted for twenty days in the meantime; the defendants being ordered to show cause why the restriction should not be made permanent. The suit causes a great deal of interest in the United States.

The State of Pennsylvania, U.S., insists upon the forfeiture of the charters of the Western Union Telegraph Company by reason of its consolidation with the A. and P.

"The New York Legislature," says the *Operator*, "after putting the W. U. Company to great expense to prevent the passing of an act requiring the running of wires underground through cities, now comes forward with another source of annoyance in the shape of a bill substituting iron telegraph poles in cities in place of the present wooden ones."

A bill has been introduced into the legislature of the state of Wisconsin, U.S., which requires that any telegraph company doing business in that state shall report to the State Treasurer on or before the 1st of April of each year the amount of its gross receipts, on which it shall be called upon to pay a tax of four per cent. The bill also limits the message tariffs and otherwise interferes, a penalty of 5,000 dollars being imposed in case of non-compliance with the law. It is expected to be bitterly opposed by the telegraph companies which it affects.

A new American telegraph company to be called the "States Union Telegraph Company" has been organized in Boston. The capital is ten million dollars, and its object is to construct lines between all the large cities of the United States.

A telegram from Berne, dated March 21, states definitely that the Argentine Confederation will be admitted into the International Telegraph Union on April 1.

The Accumulation by Reaction Principle of Dynamo-electric Machines has been the subject of a recent controversy in the columns of one of our contemporaries. From this discussion it appears that the principle of accumulating electricity in magneto-electric machines by causing the electricity excited in the revolving armature in turn to intensify the exciting electro-magnets has been almost simultaneously applied by Dr. Werner Siemens, Professor Wheatstone, and Mr. S. A. Varley. Mr. Robert Sabine has summed up the respective claims of these gentlemen in the following words: "The date when an undefined idea of making any machine first occurs to an inventor is of very little comparative importance, unless the idea be productive of some evidence of its being, without which one would naturally be inclined to suspect that memory might after the lapse of years be a little treacherous. Who had the first happy inspiration of a reaction machine we can scarcely expect to know now. Of its fruits we have better evidence, and I venture to think that the claims of the three inventors in question stand thus:—Professor Wheatstone was the first to complete and try the reaction machine; Mr. S. A. Varley was the first to put the machine officially on record in a provisional specification dated Dec. 24, 1866, which was therefore not published till July, 1867; Dr. Werner Siemens was the first to call public attention to the machine in a paper read before the Berlin Academy on the 17th of January, 1867." In connection with this subject our attention has been called to a forgotten English patent, No. 2198, of the year 1854, and in the name of Sóren Hjorth, Copenhagen. This patent clearly sets forth the mutual accumulation principle of magneto-electric machines as will be seen from the following extract:—"The main feature of this battery consists in applying one, two, or several permanent magnets of cast iron, and shaped as shewn, in connection with an equal number or more electro-magnets, shaped as indicated in drawing, in such a manner that the currents induced in the coils of the revolving armatures are allowed to pass round the electro-magnets; consequently, the more the electro-magnets are excited in the said manner, the more will the armatures be excited, and more electricity of course induced in the respective coilings; and while a mutual and accelerating force is thus produced in this manner between the electro-magnets and the armatures, an additional or secondary current is at the same time induced in the coiling of the electro-magnets by the motion of the armatures, the said current flowing in the same direction as that of the primary current after having passed the commutator." This important patent received provisional protection only, because notice to proceed was not given in the time prescribed by the Act.

Influence of Electricity on Evaporation.—M. Mascart has just communicated the results of his experiments on this subject to the French Academy of Sciences. Since atmospheric electricity has been known to exist, it has been supposed to owe its origin chiefly to the evaporation of water, and the experiments of Pouillet seemed to prove this supposition to be true. But more recent researches have cast doubts upon it. It was observed that in all the cases of violent ebullition in which electricity was developed by evaporation, there was always to be found small grains of solid matter projected upon the walls of the vessel; and these appear to have played an important part in the production of electricity, for, when care was taken entirely to exclude them, no electricity was produced. Again, the quantity of electricity furnished by gentle evaporation, was very feeble and inappreciable. M. Mascart's experiments had an opposite aim. They were intended to determine if electrification modified the evaporation of water. Accordingly, he arranged a set of small basins, containing water, or moist earth, under the conductors of a Holtz electrical machine, maintained at a high and constant potential. The basins themselves were connected to earth, as also were the other poles of the machine. The electrified conductors over the basin were in the form of a grating, which did not check evaporation, and were supported about 2 centimetres

over the evaporating surface. The quantity of water evaporated by each basin was determined daily. M. Mascart found that electrification of the conductors accelerated the rate of evaporation whatever the sign of the electricity, and in some cases it doubled the rate. He also found, however, that slight variations of temperature completely masked the electric influence, and concordant results could only be obtained in a closed box regularly dried and kept in a cellar, where the temperature only varied form 4° to 6° during nearly a month. M. Mascart did not clearly determine the rates of evaporation under positive and negative charges; but he continues his experiments. However this curious effect of electricity be brought about, it seems to be appreciable only under very high charges. In connection with it, we may refer to the experiments of Mr. Cassamajor on the motions of camphor in electrified water, see TELEGRAPHIC JOURNAL, Dec. 15, 1877.

THE HOWE SEWING-MACHINE ELECTRO-MOTOR.—Any day in Queen Victoria Street, City, this tiny electromotor may be seen busily at work plying the stout needle of a Howe sewing-machine at the rate of 500 stitches a minute. It is perched upon the corner of the table of the machine and is actuated by 3 large double plated Grove cells. It consists of a cross shaped electromagnetic armature, revolving on an axle, which carries the driving pulley. This armature rotates in the interpolar space formed by five bar electro-magnets, set radially with respect to each other and to the armature. The outer poles of these magnets are united by an armature of soft iron, which also forms the outer protecting case of the motor. The current magnetises both armature and electro-magnets, and it is made and unmade by a commutator so as to pull forward each arm of the cross-shaped armature one after another with the least possible "dead point" in the rotation. The motor is in the form of a short cylinder, some 6 inches in diameter, and 7 inches long, and weighs only 16 lbs. All the iron employed is cast. The resistance of the circuit is about $\frac{3}{4}$ ohms. Three Grove or Bunsen cells drive it for 30 hours without changing the solutions; but as there are objections to the acid fumes of these batteries in a house, it would be an advantage to be able to replace them by some less obnoxious kind, which would be equally powerful and constant. A special feature of the motor is the poles of the electro-magnets and armatures, which are serrated like the teeth of a saw so that as the armature passes a pole its teeth coincide with the gaps between the teeth of the pole. This form is held to concentrate the magnetic power.

CURRENTS IN LIQUIDS.—M. Herwig has been continuing his researches on the passage of currents through liquids. He finds that they do not strictly obey Ohm's law, there being at first contact a retardation of the current, which when it does set in, resembles the discharge from a condenser. See *Ann. der Physik*, No. 12.

CAPACITY OF ELECTROLYTES.—The following results are taken from a paper by M. Herwig, in *Ann. der Phys.*, II., p. 556: It is well known that when a current of sufficient strength to decompose it is passed through a liquid electrolyte the current gradually diminishes in strength until it becomes very feeble; and if the current be then interrupted a current in the opposite direction will be set up. The effect is analogous to that produced when a condenser is substituted for the electrolyte. Assuming that the electrolyte under such condition behaves like a condenser of capacity c, and the resistance of which is $\frac{1}{W}$, the intensity of the first changing current will be a function $i = i_\infty \left(1 + k e^{-at}\right)$ of the time and the current of discharge will be another function $i^1 = i_0 e^{-at}$. In these two expressions the factor a is the same, and equal to $\frac{1}{c}\left(\frac{1}{R} + \frac{1}{W}\right)$, R being the resistance of the circuit external to the liquid. By measuring with a galvanometer the values of i and i^1 at different instants, we can then obtain the quantity a, and, as W can be deduced from the intensity towards which the discharging current tends, we can calculate c.

In this way, c is found for the same experiment to have very different values (in the ratio of 1 to 10), increasing with the time, as well for the current of charge as for that of discharge. The resistance W has otherwise nothing in common with the resistance that the same liquid presents when traversed by a current strong enough to decompose it; (in an experiment where the latter resistance was 6 ohms, W was found to be = 1,031 ohms). For the rest, W does not obey Ohm's law, and increases much less rapidly than the resistance of the platinum plates serving for electrodes; it even varies when the direction of charge is changed.

ELECTROLYSIS OF DILUTE SULPHURIC ACID.—It was observed by Faraday that the dilute sulphuric acid under electrolysis yielded a volume of oxygen less than one-half that of the hydrogen simultaneously disengaged, and attributed the deficit to the formation of hydrogenated water. M. Berthelot is of opinion that it cannot be oxygenated water which is formed nor even ozone. It is, he says, only formed during the electrolysis of sulphuric solutions, and is therefore likely to be persulphuric acid.

THE ACTION OF THE COPPER-ZINC COUPLE ON OXY-SALTS. — Dr. Gladstone and Mr. Tribe have recently been investigating this subject and have communicated a paper upon it to the Chemical Society. In 1873 it was proved by Prof. Thorpe that the copper-zinc couple converts the nitrogen of nitre in presence of water into ammonia. It had been previously observed, however, by Messrs. Gladstone and Tribe that nitrates were first formed, and they have studied the reaction completely. The chemical change is a

very variable one. At the beginning, ammonia and its equivalent of potash are made in increasing quantities until the time when the maximum amount of nitrite is produced; after which the rate of production of the alkalies rapidly increases and the supply of nitrites falls off. Solutions of ammonia containing 0·026 and 0·256 per cent. increase the action of the couple, but stronger solutions diminish it. Solutions of potash from 0·08 to 60 per cent. increase its action. The explanation of the change advanced by Messrs. Gladstone and Tribe is that the copper and zinc electrolise the nitre with the formation of nitrate of zinc, the nitre being reduced at the negative pole through the agency of the potassium. The copper-zinc couple also converts the potassium chlorate into potassium chloride, but no chlorites or hypochlorites are then formed. The net results arrived at by the authors are:—1. The action of the copper-zinc couple on these oxy-salts is of an electrolytic nature. 2. The negative radical combines with the zinc whilst the positive radical or its equivalent of hydrogen from decomposed water is set free against copper crystals. 3. The salt is reduced and hydrogenised in the vicinity of the negative metal; and it is probable that hydrogen is set free against the copper, but is condensed by the finely divided metal, and in that condition reduces and hydrogenises. The couple acts in the same way on ammonium nitrite.

Patents.

844. "A new mode of conveying sound from vibrating and sound producing or receiving bodies."—E. C. WALKER, March 2.

861. "Apparatus for the production of light by electricity."—T. F. SCOTT, March 2.

915. "An improved method of and apparatus for transmitting power by electric currents."—H. C. SPALDING, March 6.

929. "Electric lamp lighting apparatus." — P. DRONIER, March 7.

953. "Electro-magnetic machines."—J. H. JOHNSON (communicated by Z. T. Gramme and E. L. d'Ivernois), March 9.

ABSTRACTS OF SPECIFICATIONS.

1693. "Expansion and contraction coupling for signal and telegraph wires."—G. PICKERSGILL. Dated May 1, 1877. 2d. The wire of semaphores being liable to change in length, according to temperature, this consists in means for allowing them to do so, always preserving the proper degree of tightness in the wire. A metal tube or cylinder contains one or more piston-rods, fitted with rings or discs of india rubber, within the tube. The piston-rods, after passing through the covers on the ends of the tube, are attached to the wire. *(Not proceeded with.)*

1702. "Producing and recording electric signals."—F. H. VARLEY. Dated May 2, 1877. 6d. This consists in improvements in the battery key and receiver of a telegraphic circuit. The battery described is the carbon and oxide of maganese battery, with provision for keeping mercury round the zinc, so that it be constantly amalgamated; dilute sulphuric acid being preferred as the exciting liquid. A transmitter for railway signalling is also described. It is formed of a vertical axis to which is joined a reversable handle, or a swing tablet showing on one side "line blocked" and on the other "line clear": this tablet, when pressed, signals to the receiving station the announcement corresponding to the direction in which the tablet has been turned. The electro-magnetic receiver is so constructed that the needle is permanently deflected even after the deflecting current has stopped, until it be freed by the reversal of the current. It is made of a double frame of iron to which are connected electro-magnets. An induced magnetic needle turns freely between them. These frames are employed as conductors of magnetism to maintain the direction of magnetism in the indicating needle, whilst the current passing through the coils shifts the plane of magnetic attraction from one portion of the frame to the other, causing the needle to be held over in the direction of attraction, or liberated and reversed in position by a reverse current through the coils.

1829. "Electro-magnetic apparatus for developing motive power."—RICHARD WERDERMANN. Dated May 10, 1877. 6d. A conical armature of soft iron is hinged at one end of its axis on a universal joint so that it is free to oscillate in such a manner that the axis describes a cone. This peculiar oscillation or rocking is produced in order to allow the free end of the perpendicular or axis of the cone to rotate an axle by means of a short crank. It is effected by flattening out the edge or base of the cone into a disc, which is made to rotate and oscillate, in short to wobble, by a series of electro-magnets on each side of it, the magnets being made and unmade at the proper time. A full account of the arrangement is given in the TELEGRAPHIC JOURNAL for January 15th.

1871. "Recording electric telegraph signals."—C. H. SIEMENS. Dated May 14, 1877. 6d. This consists in a recorder formed of an aluminium coil moving in a magnetic field and deflecting to and fro according to the kind of current passed through the coil. A fine marking point connected to the coil traces the motions of the latter on a moving surface of smoked paper. A full account of the arrangement is given in the TELEGRAPHIC JOURNAL for March 1, 1878.

2064. "Skating or bicycling."—H. HORSTMAN. Dated May 26, 1877. 6d. This consists in a plan for enabling a person to skate or ride a bicycle on certain lines of rail of special construction, and of applying electro-magnetic motive power to drive the skates or bicycle. Magnetism may not only be used to propel the skates but to cause them to adhere to the rails.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—It may perhaps interest some of the readers of your valuable journal to know that they can double the volume of sound coming from the telephone by a very simple addition to it. My experiment was as follows:—To the back of the head of a telephone, immediately behind the disc, I attached a foot of half-inch flexible tubing, and to the end of the tubing,

remote from the telephone was attached a turned wood cone large enough to cover the ear. On applying the telephone to one ear and the cone to the other the vibration of the plate was given off to both ears from the same telephone, the sound being doubled thereby. Accept my apologies for intruding on your valuable space, and believe me,

Yours obediently,
FREDERICK JOHN SMITH.

Mary Street House, Taunton.
March, 23, 1878.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

At the ordinary general meeting held on the 27th February, a large audience assembled in consequence of the varied and attractive programme which had been issued, the chief feature of interest being Mr. W. H. Preece's explanation of the Phonograph.

(1.) The business of the evening commenced with a communication from Dr. Muirhead, supplemented by explanatory remarks from Mr. Latimer Clark, on the chloride of silver cell of Mr. Warren de la Rue. This cell was first described by Mr. de la Rue before the Society of Telegraph Engineers on the 28th April, 1875, and again in a joint communication by MM. de la Rue, Müller and Spottiswoode, to the Royal Society (Proc. R. S. No. 160, 1875); an illustration of it has recently appeared in this journal. It consists of a tabular glass vessel 4 or 5 inches high, and about 1 inch in diameter, closed by a stopper of cork or paraffin wax. Through the stopper pass two silver wires, one of which has a cylinder of silver chloride cast on it, the other being attached to a small cylinder of pure zinc. The chloride cylinder is loosely cased in with a tube of parchment paper, and the vessel is nearly filled with a solution made by dissolving from 20 to 25 grammes of sodium chloride, zinc chloride or (preferably) ammonium chloride, in one litre of pure water (say 1750 grains to the gallon). The electro-motive force is about 1·06 volt, and its resistance 2 or 3 ohms, according to the distance between the zinc and chloride. A preliminary investigation of the qualities of this cell has been made at Mr. Clark's request by Dr. Muirhead, and the following figures show the result of comparison of 60 cells. One cell was chosen as the standard, and was found to give a shunted deflection representing a full deflection of 346,730 divisions through a Thomson galvanometer of 5,220 ohms resistance. Each of the other cells was then joined up, in opposition to the standard and the following deflections were obtained:—

0	260
45	200
+45	110
180	280
130	260
210	250
0	250
170	210
170	130
165	230
130	150
190	+310
120	120
50	140
20	90
310	60

250	+250
175	0
380	+215
130	100
180	430
270	120
175	380
100	150
290	280
270	+70
110	+20
220	75
130	10
220	

All those not otherwise marked are *minus*. The maximum difference thus observed was 1-80th of the standard cell.

It is claimed for this cell, that the electro-motive force remains very constant for long periods, and that it is not affected by shaking. These qualities together with the small size of the cells, render them eminently suitable for testing purposes, especially on board ship.

The first cost is about one shilling per cell, exclusive of the silver chloride which costs about two shillings per cell. The action of the cell is to reduce pure silver, and this can be reconverted into chloride at a small cost.

(2.) The second subject dealt with was Dr. Byrne's Pneumatic Battery, exhibited by Mr. H. Edmunds and described by Mr. Preece. This battery is a peculiar modification of the bichromate of potash battery. The positive plate is of zinc as usual; the negative plate is a compound one of lead, copper, and platinum. The solution is made in the proportion of 12 oz. potassium bichromate to 1 pint of sulphuric acid and 5 pints of water. When the battery is in action, air is forced into and through the solution by means of a bellows, communicating with a perforated tube inside the cells, a most remarkable rise in the current strength being the result.

With the ten cells exhibited by Mr. Edmunds, a 30 in. length of No. 14 platinum wire was raised to incandescence, and the stout copper electrodes were also sensibly heated. The internal resistance of this cell is so small that Mr. Preece had been unable to measure it with the apparatus at his command.

The great increase in the strength of the current which follows the pumping does not readily admit of explanation, and seems to call for further experiment. Mr. Ladd, the maker of the cells exhibited, stated that he had pumped in successively air, oxygen, and hydrogen, but without observing any difference in the result. He therefore concluded that the effect was principally a mechanical one; but he also attributed some of the success of this battery to low resistance of the negative plate. Mr. Edmunds stated that Dr. Byrne also considered the efficacy of the cell due in great measure to the compound plate, as he had obtained remarkable results even without the pumping, employing a solution of sulphuric acid only. Dr. Byrne further considered the effect of the pumping to be a depolarisation of the plates. Mr. Preece's experiments appeared to give a verdict at variance with some of these opinions. He had found the electro-motive force to be the same when the battery was quiescent, as when the pumping was going on, viz., about 1·7 volt. It was suggested by Professor Adams that the circulation of the liquid, caused by the influx of air, continually brought fresh acid into contact with the zinc plate and thus gave rise to the enhanced current. Mr. Preece, however, pointed out that if this were the case, the effect ought to be instantaneous or nearly so, whereas it was observed that the increase of current strength was gradual, as was also

the diminution on stopping the pumping. It was also noticed that a great amount of heat was generated within the cell itself, and this has been variously attributed to the diminution of internal resistance, and to the increased chemical action going on in the cell.

(3.) Mr. W. H. Barlow, F.R.S., M.I.C.E., next exhibited his "logograph," an instrument designed by him about four years ago with a view to making it an automatic short-hand writer, a result not yet attained. A trumpet-shaped mouthpiece is closed at the smaller end by a thin india-rubber diaphragm about 2¼ in. in diameter, which carries a fine camel-hair pencil moistened with an aniline ink. A strip of Morse paper is drawn past the pencil by clockwork. On speaking into the mouthpiece the diaphragm is set in vibration and agitates the pencil which thus describes fine curves on the paper slip closely resembling those produced by Thomson's "Siphon Recorder." These curves are the graphic representation of the sounds uttered, and are produced directly by the mechanical impulse of the puffs of air sent out in uttering them. Repetitions of the same word or sound gave almost exactly similar curves, the consonants usually giving evidence of a much more violent agitation than the vowels. Slight disturbances however were noticeable which would materially increase the difficulty of reading, but it is not improbable that further improvements in the machine may enable a practised eye to decipher the words represented by these curves with as much ease as telegraphic signals can be read.

(4.) The last and most eagerly looked for item of the evening was the description by Mr. Preece of the phonograph, recently invented by Mr. Thomas Alva Edison, of New York. This instrument, which has been lately described in these pages, consists essentially of a rotating cylinder or drum, and a vibrating diaphragm carrying a point which produces indentations on a sheet of tinfoil carried by the drum. The drum, which is of brass, has a groove cut on its surface spirally from end to end, and is fixed on a screwed axle of the same pitch, turning in a screwed bearing, so that a motion of rotation is accompanied by a lateral traverse. A mouthpiece closed by a metal diaphragm is fixed on a stand, which can be moved by an adjusting screw in a direction at right angles to the drum. The centre of the diaphragm carries a small steel pointer; and over the surface of the cylinder is laid a sheet of tinfoil. On speaking or singing into the mouthpiece, the cylinder being at the same time rotated, the diaphragm is thrown into vibration, and these vibrations cause the steel pointer to impress greater or less indentions upon the tinfoil in a line coincident with the spiral groove. Three instruments were exhibited, viz., one sent over by Mr. Edison, a second made for experimental purposes by Mr. Pidgeon, a London gentleman, and a third constructed by Mr. A. Stroh, the well-known mechanician of London. In each of the two former, the axle was provided with a fly-wheel, to give a more uniform motion than could be obtained with the unaided hand; in the third, however, a much more uniform motion was attained by driving the cylinder by clockwork, to which an ingenious governor was applied to regulate the speed.

To reproduce the sounds it is only necessary to remove the mouthpiece a short distance, shift back the cylinder, and again bring up the diaphragm so that the pin presses lightly on the foil. The cylinder being now turned, the pointer retraces its steps, and imparts to the diaphragm vibrations which are the counterpart of the original ones. In the original instrument, made by Mr. Edison, as also in that made by Mr. Pidgeon, a separate diaphragm of paper is used for reproducing the sounds, the diaphragm being attached by a silk thread to a light spring, armed with a point, and pressing on the cylinder.

Mr. Preece's discourse was illustrated by practical experiments, which produced much merriment and a profound sensation; and a cordial vote of thanks was passed to Mr. Edison, to his representative, Mr. Puskas, to Mr. Pidgeon, and to Mr. Stroh.

At the ordinary general meetings held on the 13th and 27th ults., a paper by Mr. J. Gavey on "Insulators for Aërial Telegraph Lines" was read and discussed. As the subject embraced the whole history of insulators concerning which some new facts were elicited, we are compelled to postpone our remarks to our next issue.

THE INSTITUTION OF CIVIL ENGINEERS.

At the meeting on Tuesday, the 12th of March, Mr. Bateman, President, in the chair, the Paper read was "On Railway Appliances at the Philadelphia Exhibition of 1876," by Mr. Douglas Galton, C.B., F.R.S., Assoc. Inst. C.E.

The first American railroad was constructed in 1830, and about 22,000 miles were in operation in 1856, and 74,600 miles in 1875. In America the railway is the pioneer road, and frequently the sole means of communication. The object has accordingly been to make the lines as cheaply as possible in the first instances; and considerable expense has been subsequently incurred in perfecting the lines.

The subject was treated under the following heads: I. Permanent Way; II. Cars and Car Fittings; III. Locomotive Engines; IV. Railroads of 3-feet Gauge.

The main features of the standard track of the Pennsylvanian Railroad Company consisted in the shape of the head of the rail; the form of splice for the joints; the large number of sleepers, and the arrangement of the ballast. The splices were two feet in length. The outside splice had a tongue which passed over the flange of the rail and was spiked to the sleepers. The joint was suspended midway between two sleepers.

The weights per wheel in the heaviest engines were about 4½ tons. In connection with the permanent way, attention was directed to the Wharton switch, the principle of which was to carry the train off the main line on to a siding, without any break in the continuity of the main line rails.

The great distances on American lines had led to the conversion of the passenger cars into travelling hotels. The main advantage of the American form of car, which consisted of a long body supported at each end on a bogie truck, was the power of movement afforded to the passengers, and of access to conveniences. The disadvantages were, the mode of opening the windows, which slid up instead of being let down into the panels, and the difficulty of ventilation, but the latter had been overcome by a central raised roof with clerestory windows.

The use of chilled cast-iron wheels was all but universal on American railroads. Each wheel formed a single casting with the tire, and was cast in a chill, consisting of a rim of iron turned perfectly true, so that labour in turning was avoided. The necessary hardness in the chill was obtained by a mixture of charcoal iron, chiefly Salisbury iron, with broken up wheels and castings. The comparatively high price of charcoal iron had led to the substitution for it, in part, of anthracite iron, with wrought iron or Bessemer steel.

The duration of car-wheels in the United States was stated to be from 50,000 to 60,000 miles. They could then be turned up and run a further mileage. Good chilled cast-iron wheels were economical; and provided they were periodically examined, they did not appear to break so as to cause accidents.

The brakes on American railroads were, as a rule,

capable of being applied to a larger number of wheels in a train than in this country. This had probably arisen from the greater necessity for the rapid stopping of trains, owing to the absence of secure fencing and the prevalence of single lines. It seemed to be recognized in the United States, 1st, that the engine-driver should have complete control over the application of brake-power to all the wheels of the train; and 2ndly, that in the case of the accidental fracture of the couplings, the detached cars should be at once brought to rest by the action of the brakes attached to them. The Westinghouse automatic air brake was in extensive use on American railroads, especially for passenger trains. In it the air in the pipes was pumped in continually under pressure, and the brakes were applied by diminution of pressure. Smith's vacuum brake (the property of the Westinghouse Brake Company) was occasionally employed, where rapidity of action was not of paramount importance. It was less expensive, and its action was dependent on a vacuum in the pipe.

The striking fact gathered from the exhibition of railroad cars at Philadelphia was that, while the comfort of railway travelling had been practically stationary in Europe for the last twenty-five years, it had been rapidly developed in the United States within the last few years to a standard above that of Europe. The comforts were as much needed in Europe. The distances were as great; the cold was as intense; the populations to be accommodated were as numerous, and more wealthy. No doubt the control exercised by Continental Governments had had some effect in stopping improvements; but the Author believed the stagnation was largely due to the use of small carriages divided into compartments. These had actually prevented the development of comfort, while the larger American car had both suggested and afforded scope for improvement. Until European Railway Companies followed the lead of America, and adopted long carriages on bogie trucks, comfort in travelling would remain in its present unsatisfactory condition.

Locomotive engines in the United States were of a totally different type to those in Europe. The front part of the engine was supported on a bogie truck, by which a short wheel base was possible. This truck was generally so arranged that the pivot was under the centre of the smoke-box, and the front wheels were considerably in advance of the body of the engine. When a bogie truck was not used, the front of the engine was carried (except in the case of a few special engines for inclines or for switching), by a Bissel two-wheeled "pony" truck, which had a swing bolster and a radius bar pivoting from a point about 4 feet behind the centre of the truck, the weight being equalised between the pony truck and the leading pair of driving wheels.

Within the last few years companies had been formed to construct in America 8,000 miles of narrow-gauge lines, of which 2,700 miles were in operation at the beginning of 1877.

The Denver and Rio Grande Railroad was proposed to be 1,700 miles long, and between 200 and 300 miles had been completed. The promoters of this system contended that a mile of single line having a gauge of 3 feet could be made for £1,904, with rails weighing 30lbs. to the yard, or for £2,144, with rails of 40lbs. to the yard, while the rolling stock might cost £758 per mile, calculated for a length of 100 miles of road.

It was worthy of consideration whether, in the colonies, narrow-gauge railways of cheaper construction, and with cheaper rolling-stock than the ordinary gauge might not be advantageously adopted, and amply suffice for the wants of such communities.

In the discussion which followed, and which was continued at the meeting on the 19th of March, the differences between railway practice in the United States and this country, with reference chiefly to wheels and forms of carriages, were dwelt upon. The use of chilled steel tires in America was contrasted with that of wrought iron tires here.

The advantages of the American cars were upheld by some speakers as affording greater comfort, whilst Mr. Ashbury, Mr. Bramwell, and the president, considered that the English system of numerous compartments enabled passengers to travel with less disturbance, and pointed to the fact that persons always sought for a compartment with fewest passengers. Mr. Bramwell even regarded the old stage coach principle of only four inside passengers as the best, as the fewer one's fellow passengers the less chance of an objectionable person or a bore, and the fewer persons a casual bore could annoy. Mr. Ashbury pointed out that the number of doors was an advantage possessed by the English system, and mentioned the Metropolitan Railway as an instance of a line on which the American cars could not be used, with their small accommodation for ingress and egress. Mr. Finlay thought that railway companies in England had fully consulted the convenience of passengers, and that for long night journeys, as much comfort was attainable as on the American cars; and he observed that the day saloon cars on the Midland Railway were not popular.

It was remarked that the advantages possessed by American locomotives were sufficiently demonstrated by the fact that, in spite of the distance, the locomotives supplied to St. Petersburg are now procured from America.

Captain Galton, in reply, said that he had been led to offer this paper by a remark of Sir John Hawkshaw, that much might be learnt by English engineers from American practice. He considered that the system of large cars was chiefly applicable to continental countries, where the journeys resembled in length those in the United States. He thought that if, instead of the old stage coach type, the plan of the steamboat saloon had been imitated for railway carriages in the first introduction of railways, more comforts during the journey would have been attainable, and fewer appliances at stations would have been required.

PHYSICAL SOCIETY.—March 16th, 1878.

Prof. W. G. Adams, President, in the chair.

A Special General Meeting was held for the election of an *ex-officio* honorary member of the Physical Society of Paris.

The following candidates were then elected members of the Society:—J. S. Bergheim, W. M. Hicks, M.A., Dr. J. Hopkinson, M.A., D.Sc., Miss E. Prance, and T. Wills.

The Secretary read a paper by Mr. W. J. Millar, C.E., "On the Transmission of Vocal and other Sounds by Wires." The author was led mainly by a consideration of the manner in which sounds are conveyed through walls and partitions, to make an extensive series of experiments on this subject, from which he concludes that conversation can be carried on at considerable distances by simply employing stretched wires provided with suitable vibrating discs. In one experiment, two copper wires were attached to points on a telegraph wire 150 yards apart, and breathing, singing, &c., were distinctly audible; by stretched wires, extending through a house, and provided with mouth and ear pieces in the several rooms, conversation could be carried on without difficulty. The materials employed for terminals were very varied, and the vibrating disc, whether metal, wood, or india-rubber, &c., was generally formed as a drum head, the wire being fastened at its centre. The volume of

sound appears to be greater with a heavy wire, but in all cases it requires to be stretched.

The President referred to the experiments of Wheatstone on the conduction of sound by solid bodies, especially long wooden rods. Some years ago, M. Cornu, in conjunction with M. Mercadier, made experiments which showed that vibrations can be transmitted along a copper wire, and rendered visible at the distant end on a rotating blackened drum. The free end of the wire was attached to a piece of copperfoil fixed at its base and provided with a point, which left a clear trace on the drum when the distant end was attached to, say, a vibrating tuning fork.

Mr. W. H. Preece described some experiments made in September of last year by Mr. A. W. Heaviside and Mr. Nixon at Newcastle-on-Tyne on this subject. They find that a No. 4 wire gives the best results. The terminals were wooden discs, about one-eighth inch thick, and to these the wire was attached "end on," but speech could be distinctly heard by laying such a disc on any intermediate point of the wire. When the wire was particularly still, speech was audible up to 200 yards.

Mr. G. W. von Tunzelmann then read a paper on the "Production of Thermo-electric Currents in Wires subjected to Mechanical Strain." The wire, of iron, steel or copper, was stretched vertically between two cans, which could be maintained at different temperatures: it was fixed in the base of the lower can, and held in the upper one by a clamp attached to the shorter arm of a lever, to the longer arm of which the stretching weight was applied. The free ends of the wire were joined to copper wires which led to the Thomson galvanometer, these junctions being covered with cotton wool. He has succeeded in reconciling the contradictory conclusions arrived at by Sir W. Thomson and M. Le Roux, for, whereas the former only used moderate strains, the latter worked near the breaking limit, and the author finds that if the weight be gradually increased the direction of the current changes, and hence these two authorities found the currents to flow in opposite directions. A great number of experiments were made, and from them it is evident that on applying a strain the deflection does not immediately attain a maximum, but it gradually rises for about eight minutes and then gradually falls, attaining a stationary point at the end of about twelve minutes.

Professor Adams then exhibited a simple arrangement for projecting Lissajous' figures on to the screen which has been made by his assistant Mr. Furze.

Dr. Guthrie exhibited an experiment to show the behaviour of colloids and crystalloids in relation to electrolysis.

THE METEOROLOGICAL SOCIETY.

The usual monthly meeting of this society was held on Wednesday, the 20th instant, at the Institution of Civil Engineers; Mr. C. Greaves, President, in the chair. Mr. B. C. Smith was elected a Fellow. The discussion on Dr. Tripe's paper "On the Winter Climate of some English Sea-side Health Resorts" was resumed and concluded, after which the following papers were read:—"Notes on a Waterspout," by Captain W. Watson, F.M.S.; "Notes on the Occurrence of Globular Lightning and of Waterspouts in Co. Donegal, Ireland," by M. Fitzgerald; and "Observations of Rainfall at Sea," by W. T. Black.

The discussion on the subject of waterspouts and globular lightning was adjourned till the next meeting on April 17th.

General Science Columns.

MINUTES OF PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS, SESSION 1876-77. PART IV.

The paper at the commencement of this volume, by Mr. Souttar, contains a full account of the methods of laying down tramways, the different kinds of foundation sleepers and rails employed, and the advantages or disadvantages of each. The preference is given to a concrete bed, if sufficient time for setting is allowed, if not, and the layer is thin, bituminous concrete is best. A longitudinal timber sleeper affords the smoothest road, and, with proper care, will last as long as the rail. Hard stone answers best for the paving between the rails, as wood and asphalt wear at the edges, and the rails become loose, and a macadamised road is difficult to maintain in such a narrow space. Till 1872 traction by steam was practically prohibited, as the rate of speed in towns was limited to two miles an hour. In that year, a select committee of the House of Commons recommended that locomotive carriages, under 6 tons, and consuming their own smoke, should be allowed to travel at the ordinary rate of vehicles drawn by horses. Tramway engines have been designed both separate from the passenger car, and combined with it. The former are to be preferred where steam is used, as the cleaning and repairing of the engine would damage a car attached to it, and any injury to the engine would cause the car to lie idle. Where compressed air is the motive power, the machinery is simpler, and there is not the same objection to the combination of engine and car. Mechanical motive power is estimated at almost 5d. per mile, and horse traction at 8½d.

Tramways have not found such favour in the metropolis and its suburbs, as in many provincial towns. Glasgow and Leeds, for instance, have tramways in some of their principal thoroughfares, and extending to the outskirts. The extension of tramways in London along the principal omnibus routes would be a great boon to the general public, but would probably not be welcomed by the owners of private carriages. The advantage of a tramway is that a person can be deposited at the point on the route nearest to his destination, and the journey, moreover, is performed with more regularity, and with far greater comfort than in most hired vehicles.

Sir William Armstrong in his paper entitled "The History of the Modern Development of Water-pressure Machinery" gives an interesting sketch of the circumstances which directed his attention to the utilisation of water-pressure, and the successive steps by which hydraulic machinery has been brought to its present state of perfection. The fall of water in some small streams, through steep valleys in Yorkshire, first suggested to him the idea of using water-pressure by

bringing down water in pipes from a high level. He first designed a machine combining the use of pistons with the continuous rotation of a water-wheel. He next designed a crane worked by water-pressure acting on pistons which proved very suitable for lifting heavy weights, the motion of the crane being under perfect control; and in 1846, hydraulic cranes were adopted by Mr. Hartley for the Albert Dock at Liverpool. Sir W. Armstrong, who had up to this time been a solicitor, gave up the law, and devoted himself to the improvement of hydraulic machinery. In the first instances the pressure obtained from the pipes of the water companies had been used, but in 1849, some hydraulic machinery having to be erected where the pressure thus obtained would have been insufficient, an air vessel was employed for furnishing the requisite pressure. The air vessel proved inconvenient, so high reservoir tanks were put up at Great Grimsby Docks in 1851, on the introduction of hydraulic engines for opening and closing the sluices and gates, and for working the cranes. The next improvement was the invention of the "Accumulator" as an economical substitute for a high reservoir tank. We referred in the last number to this appliance, as well as to the uses and advantages of hydraulic machinery, so we need only mention that amongst the numerous applications of this system not the least valuable has been its employment for moving the heavy guns with which the name of Sir W. Armstrong is so honourably connected.

A paper "On Foundations," by Professor Gaudard of Lausanne, appears in this volume which contains a very complete record of the various methods adopted in constructing bridge foundations.

EDDYSTONE LIGHTHOUSE. — The first lighthouse built on the Eddystone rocks in 1670, was destroyed in a violent storm in 1703. The second, erected in 1706, was destroyed by fire in 1755. The third exhibited its light for the first time on October 16th, 1759, and it was hoped till recently that this lighthouse would stand for ages, as a lasting monument of Smeaton's skill. The sea, however, unable by direct assault to overthrow the structure, has undermined it by disintegrating the rock on which it stands; and a new lighthouse will have to be erected on some adjacent site. It has been suggested that the Eddystone rocks might be removed, and a lighthouse dispensed with, but to obtain a safe depth of water of seven fathoms over these rocks, about 1,750,000 tons of rock would have to be removed by blasting; and also about 250,000 tons of rock from the Hard Deeps Shoal, forming a total of about 2,000,000 tons, the cost of this has been estimated at £500,000. The Elder Brethren of the Trinity House have decided to erect a new lighthouse, without giving further consideration to the question of the removal of the rocks, as they consider, that in addition to being a warning against a particular danger, the light in that position is invaluable in affording a leading light into Plymouth, and also in serving as a link in the chain of lights for directing vessels going up or down the Channel.

FATHER SECCHI.—This illustrious spectroscopist and astronomer died at Rome on February 26th, after a brief but painful illness. Angelo Secchi was born at Reggio in Italy on July 29, 1818, and received his education from the Jesuits. After a course of physics and mathematics he emigrated to America in 1848, and taught these subjects in Georgetown College, where he made the acquaintance of Professor Henry, the leading physicist of America. His friendship with Henry probably directed him to the rising science of spectroscopy, which he has since laboured at so successfully. He returned to Europe in 1850, and was made director of the Observatory of the Collegio Remand, where he was happily left free to prosecute the solar researches to which he was now devoted. The sun, its nature, origin and growth and its influence on the planetary system which depends upon it, was the sphere of his life work, and he has summed up all that we know concerning it all the researches and the theories of himself and others, throwing light upon it, in his great book, "The Sun." Secchi maintains that the solar heat is due, not to the influx of meteoric masses upon the sun's body, but to gravitation of the gaseous mass towards its centre. He shews that by the principle of the dissociation of gases the loss of temperature by the sun does not exceed 1° C. in 4000 years, and from this concludes that the time when the earth will be too cold to support life is as yet very remote. He admits that the earth's mass is being slowly increased by falling meteorites and cosmical dust, and finds in this fact the cause of the observed secular increase of the moon's velocity. Between the years 1858 and 1870, Father Secchi carried on a series of magnetic observations, at the expense of the Papal Treasury, for the purpose of elucidating the supposed connection between magnetic phenomena and solar spots. His results shewed that years rich in solar spots were also rich in magnetic storms. He also studied earth currents for several years on a line 31 miles long, and found that they always exist in greater or less degree, that they have a prevalent direction, and that they are of abnormal intensity during magnetic disturbances. From the total eclipse of 1865, Secchi obtained a classical series of photographs of the solar disc, showing the red flames in great number and variety. It was now seen that these flames were a true solar phenomena. In 1870 he observed the eclipse from Agosta, and succeeded in proving that different parts of the corona gave different spectra. Secchi was appointed by Pope Pius IX. to continue the trigonometrical survey of the Papal States; and obtained the great prize of a hundred thousand francs at the Paris Exhibition of 1867, for his "meteorograph." He was a member of many learned bodies, and founded the Italian Spectroscopic Society.

A gas well in Kansas is said to be used for raising steam, cooking, and illuminating.

It is stated that the Eucalyptus cannot be proof against fire as has been reported, since it is employed as fuel in Australia. There is no doubt, however, that it is superior to most woods in resisting the ravages of *termites* or white ants.

Liquefaction of Air.—Attention has been called to the forgotten researches of Mr. Perkins "On the Compressibility of Water, Air, and other Fluids," a short account of which appeared in Thomson's *Annals of Philosophy*, N.S., Vol. VI., 1823, and a fuller account in the *Philosophical Transactions* for 1826. In both of these Mr. Perkins announced that he had liquefied atmospheric air, and other gases, by a pressure of upwards of 1000 atmospheres, thus anticipating the late famous achievements of MM. Pictet and Cailletet His apparatus was very similar to that employed by M. Cailletet, and he thus describes his results: "In the course of my experiments on the compression of atmospheric air by the same apparatus which had been used for compressing water, I observed a curious fact which induced me to extend the experiment, viz., that of the air beginning to disappear at a pressure of 500 atmospheres, evidently by partial liquefaction, which is indicated by the quicksilver not settling down to a level with its surface. At an increased pressure of 800 atmospheres, the quicksilver was suspended about $\frac{1}{8}$ of the volume up the tube or gasometer; at 800 atmospheres it remained about $\frac{1}{4}$ up the tube; at 1000 atmospheres, $\frac{1}{2}$ up the tube, and small globules of liquid began to form about the top of it; at 1,200 atmospheres the quicksilver remained $\frac{3}{4}$ up the tube, and a beautiful transparent liquid was seen on the surface of the quicksilver, in quantity about $\frac{1}{1000}$ part of the column of air. On another occasion a second tube was charged with "carburetted hydrogen" and subjected to pressure; it began to liquefy at about 40 atmospheres, and at 1,200 atmospheres the whole was liquefied. These results were obtained in January, 1822, and Mr. Perkins, from lack of chemical knowledge, could not say definitely that the liquids obtained were what they appeared to be; but left the matter for others more learned to judge. In connection with this subject Professor T. E. Thorpe, in a letter to *Nature*, points out that it is not strictly true that all gases have now been liquefied, the most recently-discovered gas—phosphorus pentafluoride—not having as yet been seen in the liquid state.

American Railway Cars.—At the meeting of the Institution of Civil Engineers, on March 12, Mr. Douglas Galton, C.B., F.R.S., read a paper on the "Railway Appliances at the Philadelphia Exhibition of 1876," from which we extract the following information concerning the American carriages:—The great distances on American lines has led to the conversion of the passenger cars into travelling hotels. The main advantage of the American form of car, which consists of a long body supported at each end on a bogie truck, is the power of movement afforded to the passengers, and of access to conveniences. The disadvantages are the mode of opening the windows, which slide up instead of being let down into the panels, and the difficulty of ventilation, but the latter has been overcome by a central raised roof with clerestory windows. A car for sixty persons has a length of body of 48 feet, a width of 9 feet 6 inches, and a height of 7 feet 10 inches at the sides and of 10 feet 3 inches in the the centre. Such a car would weigh, when empty, 650lbs., and when full 783lbs. per passenger. Sleeping cars for sixty-four persons are made with a body 61 feet long, and weighs when empty 812½lbs., and when full 945½lbs., per passenger. A class of vehicle, recently adopted, seems likely to come into greater use. This is the refrigerator car, by which the produce of California is brought to the Eastern States, and the delicate fruits of the South, and fish from the Gulf of Mexico are taken to Chicago. These cars are fitted with ice-boxes, and are of various patterns. A very efficient cooling surface is provided by two ice chambers on each side of the car, or four in all, extending from the top to the bottom, and fed through hoppers in the roof. These boxes being placed 3 inches from the sides allow a free circulation of air all round. Cars were formerly heated by open iron stoves, but these have been the cause of many frightful fires, and the Baker car-warmer is now the means in favour. By this the heat is supplied from hot-water pipes laid round the car on the floor-level, the water being heated in a coil of the pipe which passes through a circular iron stove. The fire-box of this stove is of wrought iron, and this again is contained in a second covering of iron, terminated in a chimney. There is no instance on record of fire having been caused by this appliance. For the circulation, both ends of the pipe are inserted in a close cylindrical cistern on the roof of the car. The liquid used is a saturated solution of salt and water, as this solution does not freeze at ordinary low temperatures. The safety valve has a compressible india-rubber ball, as the crystals, of salt prevent a metal seated valve from shutting tightly. The average allowance of heating surface in an ordinary car is 11 feet of 1¼ inch pipe per passenger.

New Source of Error in Compasses.—A correspondent in the *American Polytechnic Review* draws attention to a hitherto unsuspected source of error in readings taken on a magnetic compass. The writer found a singular unsteadiness in the needle of his surveying compass, and ultimately traced it to the ebonite ring surrounding the lense of the magnifier which was fixed over the compass card for the purpose of reading the scale. The ring was polished, and it was found to have become highly electrified by friction in handling it. The electrification attracted the slender

needle delicately poised and insulated on its pivot-piece of agate, and caused an uncertainty in the observations. This disturbance was found to be greatest in dry cold weather, and when the ebonite case was new and clean. Examination of other magnifiers, such as those with brass, German silver, and horn frames, all of them showed signs of magnetic attraction arising from impurity.

BALATAH. — A German contemporary states that "balatah," the hardened milk of the bully-tree found on the banks of the Amazon and Orinoco Rivers in Guiana, has been lately imported as a substitute for gutta-percha which it greatly resembles. It is tasteless, smells like gutta-percha when warmed, has the same leathery toughness, but is even more elastic. It becomes plastic at 50° C., and melts at 150° C. It is partly soluble in pure alcohol and ether, wholly soluble in tepid turpentine, and in cold benzol and carbon di-sulphide. It is unaffected by caustic alkalies, and concentrated hydrochloric acid; but warm concentrated nitric and sulphuric acids have the same corrosive action upon it that they have on gutta-percha. It becomes strongly electrified when rubbed, and as it is a better non-conductor of heat than gutta-percha, it is probably a better non-conductor of electricity also. Its higher melting point is also in its favour over gutta-percha. Each tree yields from one-third to one-half a a kilogramme of "balatah" per year. This substance is evidently worthy the attention of our cable manufacturers.

MINERAL WEALTH OF TURKEY.—The Grand Vizier is doing his best to create new resources, but he is nearly at his wits end. As a last expedient he proposes to lease the working of the coal mine at Heraclea, on the Black Sea, in security for a new loan he is trying to negotiate. This mine produces a good coal, and, as it lies near the sea, there is but little difficulty in the transport of coal. The Turks have never been successful in mining operations. They have but few men of practical science, and then there is so much rascality among their officers that there is but little net revenue from such undertakings. They are too jealous of foreigners to concede their mines to them. The empire abounds in mineral wealth of all kinds, particularly Thessaly, Bosnia, and Asia Minor. On the slopes of Olympus, in the vale of Tempe, an English company has for many years been engaged in mining operations, chiefly among the silver and gold deposits embedded in the fanes of this rendezvous of the gods of Grecian fable. This is the only foreign company of any note that has been able to obtain a valuable concession in the mineral districts. Bosnia abounds in copper, lead, zinc, silver, and iron of the first quality. Should it fall into the hands of Austria, as it is likely to do in the settlement of the Eastern Question, it will prove a source of great wealth to that government. It is the opinion of a celebrated Russian scientific writer, who explored Asia Minor in detail some ten years ago, and who published the results of his survey, that the sands of the Pactolus if properly worked would afford from the accumulated deposits it has piled up on its shores a rich yield in gold, if not as great as it did to Croesus, yet in quantities that would astonish the world. At various epochs, the Pactolus has received its fame as a gold bearing stream. The grains of this precious ore formed in its bed and on its shores, are, no doubt, triturated from the quartz rocks in the mountains where lie its foundations. In the time of the Lydian Kings, the gold treasure of the Pactolus made Sardis the richest city in the eastern world. Shafts sunk in the bowels of the mountain, and crushing mills after the California pattern might render the Pactolus and its mountain region as famous as in ancient times.—*Engineering and Mining Journal* (American).

SUBMARINE LAMP. — Messrs. Barnet and Foster's submarine lamp consists essentially of a spirit lamp flame, fed by a jet of pure oxygen. The spirit lamp with its lense is very light and is easily carried in the diver's hand. The oxygen is contained in a wrought iron bottle where it is compressed to about thirty atmospheres, and communicates with the lamp by a short flexible pipe. The light is very brilliant and lasts about four hours. Provision is made for the products of combustion escaping from the lamp by suitable valves. The great advantage of this lamp is its self-dependence, since no pipes or electrical connections with the surface are required.

FORM OF METEORITES.—In the manufucture of Portland cement at Vienna, a stream of air is projected against the blocks of stone heated to a white heat, and it has been noted that the angles of the stone are frayed away to dust by the impinging air. This fact has suggested to M. Suss an explanation of the rounded form of meteorites, which traverse the air in a state of incandescence.

PREPARING SODIUM AMALGAM.—To do this without danger, Mr. H. N. Draper recommends allowing the mercury to run in a thin stream to the melted sodium, which is to be held in a bath of paraffin. The quantity of mercury added depends on whether solid or liquid amalgam be desired. Liquid amalgam can be poured off, and solid amalgam congeals sooner than the paraffin. Any paraffin adhering to the amalgam can be washed off by means of ether.

HARDENED GLASS.—Herr Lamek, a German chemist, warns his scientific brethren that vessels of hardened glass are very apt to break spontaneously, that is, without any appreciable shock being given to them. On one occasion with him, a filtering flask in quite an undisturbed position suddenly burst into a thousand pieces, several of which struck his face. This defect has, we believe, been found to be due to over-hardening, and

can be readily detected by a polarisator, which shows a prevalence of violet tints in over-hardened specimens; and by exposure to water at a certain temperature. It can therefore be guarded against in future.

COATING IRON WITH PLATINUM.—M. Dodé of Paris, the inventor of platinum mirrors, has patented a process for this purpose in England. The iron article to be coated is first brushed over with a compound, formed by mixing 22 parts of borate of lead and 4½ parts of cupric oxide, in oil of turpentine. Over this is laid the platinum compound, formed by converting 10 parts of platinum into chloride and mixing this chloride with 5 parts of ether, which is then permitted to evaporate in the air, the residuum being mixed with a viscid combination of 20 parts of borate of lead; 11 parts of red lead; and some oil of lavender; and 50 parts of amyl-alcohol is added to the whole. This compound is applied by dipping the object into it and allowing it to dry in the open air, then heating it to a moderate temperature.

THE ZODIACAL LIGHT AND AURORA.—Mr. Trouvelet of Cambridge, Mass., U.S., states that his observations of the zodiacal light and the aurora during the last seven years indicate a connection between the two phenomena, for when the zodiacal light was particularly bright it was generally followed by an auroral display.

TEMPERATURE OF THE HEAD.—Dr. Lombard has recently communicated the results of some experiments of his on this subject. From these it appears that the mental activity raises the temperature of the head. So also does rousing the attention. Different regions of the head are found to have different temperatures, at least when the brain is in a quiescent condition. The experiments are being continued.

A CURIOUS PHENOMENON. — The Westinghouse Automatic Brake Company are exhibiting at their office in St. Stephen's Palace Chambers, Westminster, a working apparatus which displays the action of the brake upon a train. The apparatus consists of the platform of a single carriage, with the brake levers fitted to the wheels; and upon the platform are the brake cylinders of the other carriages of a long train, placed side by side, but yet separated by the same lengths of tubing which would intervene between them in a train. The whole action of the brake, the means of putting it off and on, and of graduating its force, may thus be conveniently studied, and the instantaneous character of its working is beautifully shown. Appended to the brake gear is a nozzle, arranged for the exhibition of a curious phenomenon which was first observed at Philadelphia. By turning a tap, a jet of air, released from great compression, issues from the nozzle, and this jet of air will support two or three balls, as balls are often supported by a fountain. The peculiarity of the effect, however, is that the jet need not be vertical, but that it will support the balls when the course of the air is at an angle of 45 degrees with the horizon. If the force of the jet in these circumstances is diminished, the balls do not fall vertically, but backwards along the oblique line of the stream of air so as to come nearer to the nozzle. The balls may be of any material, as glass, wood, or india-rubber; but a hollow india-rubber ball, which is of equal thickness throughout, displays some curious phenomena of rotation. When placed in the jet it soon begins to spin, and as the speed of its rotation increases its shape gradually changes and it becomes first an oblate spheroid, and ultimately an almost flattened disc. As it flattens, its axis of rotation gradually turns round, and, when this axis comes to be at right angles to its original position, the speed of the rotation diminishes, and the ball ultimately comes to rest. For a moment it remains motionless, supported by the jet, and then it begins to spin round again upon an axis, and repeats the former changes of position and of speed *ad infinitum*. At the International Exhibition at Philadelphia these rotating balls attracted great attention, and some of the most eminent mathematicians in the United States were occupied in formulating the laws which governed their movements.—*The Engineering and Building Times.*

FOSSIL METEORITES. — MM. Meunier and Gaston Tissandier have found, from microscopic studies, that certain ancient rocks of the cretaceous, liassic, triassic, permian, carboniferous and Devonian series, contain small magnetic spherules absolutely similar to those which have been detected in the atmospheric or cosmical dust.

PREPARING CAOUTCHOUC ON THE AMAZON.— Narrow paths lead from the hut through the thick underbrush to the solitary trunks of the thick India-rubber trees; and as soon as the dry season allows, the woodman goes into the seringal with a hatchet, in order to cut small holes in the bark, or rather in the wood of the caoutchouc tree, from which a milky white sap begins to flow through an earthenware spout fastened to the wound. Below is a piece of bamboo which is cut into the shape of a bucket. In this way he goes from tree to tree until upon his return, in order to carry the material more conveniently, he begins to empty the bamboo buckets into a large calabash. The contents of this are poured into one of those great turtle-shells, which on the Amazon are used for every kind of purpose. He at once sets to work on the smoking process, since, if left to stand long, the gummy particles separate, and the quality of the India-rubber is hurt. This consists in subjecting the sap, when spread out thin, to the smoke from nuts of the Urucury or Uauassa palm, which, strange to say, is the only thing that will turn it solid at once. An earthenware "bowl without bottom" whose neck has been drawn together like that of a bottle, forms a kind of chimney when placed over a heap

of red-hot nuts, so that the white smoke escapes from the top in thick clouds. The workman pours a small quantity of the white, rich, milk-like liquid over a kind of light wooden shovel which he turns with quickness, in order to separate the sap as much as possible. Then he passes it quickly through the dense smoke above the little chimney, turns it about several times, and at once perceives the milk take on a grayish yellow colour and turn solid. In this way he lays on skin after skin until the India-rubber on each side is two or three centimeters thick, and he considers the *plancha* done. It is then cut upon one side, peeled off the shovel, and hung up to dry, since much water has got in between the layers, which should dry out if possible. The colour of the plancha, which is at first a bright silver gray, becomes more and more yellow, and at last turns into the brown of caoutchouc, as it is known in commerce. A good workman can finish in this way five or six pounds an hour. The thicker, the more even and freer from bubbles the whole mass is, so much the better is its quality and higher the price.—*Scribner's* (American) *Magazine.*

Olive-growing in New Zealand.—A report under Government authority has recently been published in New Zealand for the purpose of encouraging the introduction of olive cultivation into the Northern Island. It appears from this that the finest qualities of olives are produced between the 43rd and 45th parallels of latitude in the neighbourhood of the sea. It is therefore probable that it could be cultivated successfully in the southern hemisphere.

A Gigantic Earth-worm is supposed to exist in Southern Brazil. It is called the "minhocca," and is reported to have been seen several times at different places during the last five and twenty years. In short it has a reputation like the great sea serpent. It is said to be fifty feet in length and five feet thick, with a snout like a pig, and a coat of armour. It is also said to make deep channels in the soil, to uproot pine-trees, and to haunt morasses and the banks of streams.

Colour Blindness.—It is stated that five per cent of the population of Germany, England, France, and Sweden are colour-blind. Dr. Stilling of Cassell, has published a set of charts for the use of railway and shipping companies in testing the powers of their *employés* to discriminate colours. They consist in chequers of different coloured squares, and the person on trial is required to count the number of squares from one point to another. If colour-blind he will be unable to do this correctly. Complete colour blindness is very rare. It generally happens that a person is blind to a pair of complementary colours, and these are either red and green, or blue and yellow. The man who is blind to red is also blind to green; and the red of the spectrum appears dark yellow to him; green up to a certain point in the spectrum appears pale yellow, and beyond that point blue; while violet seems to be dark blue. Sometimes this insensibility to red or other rays is so great that they cannot be perceived at all, red or green light not being distinguishable from darkness.

Action of Crookes' Radiometer.—According to the most recent determination, the number of molecules contained in a cubic centimeter of air at ordinary pressure, is probably something like 1,000,000,000,000,000,000,000; and consequently in a vacuum of 0·0001 of a millimetre pressure there still remain 100,000,000,000,000 molecules. Mr. Crookes considers this number sufficient to justify the hypothesis of Mr. Stoney, which explains the action of the radiometer as due to a molecular bombardment of the vanes. When these molecules are set into vibration by a heated platinum wire, they can exercise great mechanical power.

A second edition of Thomson and Tait's Natural Philosophy is, we believe, in the press.

City Notes.

Old Broad Street, March 29, 1878.

The first ordinary general meeting of the reconstructed Direct United States Cable Company was held on the 22nd instant. During the half year from July 1 to Dec. 31, the revenue, after deducting payments to the associated companies, was £84,217. Of this amount the working expenses, cost of repair, interest on debentures of the old company, absorbed £25,046, a net profit of £59,171 remaining. Out of this, it was stated that two quarterly interim dividends of 1¼ per cent. had already been paid, being at the rate of 5 per cent per annum; £12,500 had been set aside for reserve, while £16,309 had been carried forward to the next half year. In many respects, the report is satisfactory, and we are not surprised that the meeting terminated without much discussion. The chairman, we notice, said he entertained no fear of new cables being laid "under present financial circumstances," but financial circumstances, which we admit are not just now satisfactory, may change; when they change, will Mr. Pender begin to fear? We are quite prepared to believe that one of the objects of the Direct board is to maintain friendly relations with Governments and other companies—the former especially—and, in the estimation of the directors of the Direct Company, the rates for messages are, probably, as low as they think desirable or reasonable. But, for all that, they are, as we have over and over again reiterated, too high, and the public, long suffering as it is, will eventually kick against them. The report of the directors was adopted unanimously, and in the course of the proceedings it was mentioned, with regret, that Lord Bury had retired from the Board, in consequence of his appointment to the Under Secretaryship of State for War. The shareholders of the Company have certainly lost a good man.

The report of the Indo-European Co., the general meeting of which was held on Thursday, for 1877, is an extremely interesting document. In May last the company's line of telegraph along the Black Sea Coast was destroyed, owing to the operations consequent upon the Russo-Turkish war—the report speaks of it as the

late Russo-Turkish war—and it appears that as the work depended upon the result of those operations, the period within which the construction of the wires could be effected was entirely unknown. The directors, however, having obtained permission from the Russian government to erect a wire on the government line from Kertch, by Mineralin-Wodi to Tiflis as an alternative route, entered into a contract with Messrs. Siemens to do the work, and the five hundred and twenty miles were completed, the necessary stations opened, and the company's through communication with India restored on the 22nd of August—a fact which is creditable alike to the directors and to Messrs. Siemens. In the report it is significantly pointed out, that although one wire of the interrupted line along the Black Sea Coast was temporarily repaired on the 12th of January, the company would, if the directors had not promptly entered into an arrangement with Messrs. Siemens, have been deprived of revenue for eight months instead of three—a very considerable difference. It is stated that communication by a second wire of the Black Sea Coast line was secured on the 4th of February and the repairs are being proceeded with. We learn also that the company have made a claim upon the Russian Government for expenses occasioned and loss of revenue sustained. We hope that a substantial sum will be exacted. Of course, the revenue for the year was less than that of 1876, but the expenses show a reduction of £1,660, in spite of the maintenance charges having been heavier. The balance available for dividend is £15,580, and of this sum £2,830 will be carried forward, the dividend being fixed, as briefly mentioned in our last, at 3 per cent., free of income-tax. There is nothing in the statement of accounts to call for special remark. We notice under the heading of suspense an item of £5,194, which is due to Messrs. Siemens and Co. "when recovered." This may seem rather a singular way of discharging a liability, but Messrs. Siemens were consenting parties to this arrangement several years ago.

We suppose that Mr. Silver, who presided at the meeting of the India-rubber, Gutta-percha, and Telegraph Works Company the other day, recommended the best course that was possible to the shareholders, considering the circumstances. It is not pleasant to have to advocate the reduction of capital, but, at any rate, Mr. Silver made no attempt to represent things as they are *not* to the shareholders of the company. We cannot—Mr. Silver did not either—pretend to think that it would be a desirable practice for a public company to ask its shareholders to accept shares of another enterprise in lieu of shares in their own. Yet, as Mr. Batewell justly urged, the share which the shareholders of the India-rubber Company have agreed to receive is equal in value to what they had given. Their interest in the India-rubber Company has been lessened, and they have now an interest in the West Coast of America Telegraph Company. It is significant that no amendment to the Chairman's proposals was suggested.

We should not care to be holders of preference shares in the Direct Spanish Telegraph Company; we will say nothing about ordinary shareholders. But it does not look healthy when a company is obliged to carry forward to another half-year an arrear of 1s. 9d. on the preference shares. A little more business, or a little more economy, might have rendered this confession of weakness unnecessary. Undoubtedly the directors are unable to help the fact that the traffic of their cables was not greater—and it is something to be in a position to assert that the cables themselves have worked perfectly for six months—but we are disposed to think that the figures on the debit side of the profit and loss statement might here and there have been a trifle lighter. The actual items are, certainly, all small; but then the company is a small one. Considering that in six months it earned only £5,046, two hundred pounds for directors' remuneration is, some would urge, more than ample. Stationery too is put down at £94, or indeed with £50 from "stationery stock" it amounts to £144, a formidable sum in such a statement. On first looking at the balance-sheet our attention was arrested by an item, "Amounts due outstanding (telegrams)" £5,730 17s. od., but it is explained that £3,017 9s. 6d. has been paid since the 1st of January. Still, the sum due for outstanding telegrams exceeded the entire sum received for them during the half-year. The meeting of the company is being held as we go to press.

The directors of the Brazilian Submarine Telegraph Company have declared an interim dividend of two shillings and sixpence per share at 5 per cent. per annum, free of income tax, for the quarter ending December 31st.

At their meeting the Directors of the Anglo-American Telegraph Company resolved, after placing £37,500 to the renewal fund, to declare an interim dividend for the quarter ending the 31st inst. of 1 per cent. on the ordinary stock and of 2 per cent. on the preferred, both free of income tax, leaving a balance of about £7,500 to be carried forward to the next account.

The Eastern Telegraph Company announces the payment of an interim dividend of 2s. 6d. per share on the Ordinary Shares of the Company, free of income tax, on the 15th April next, in respect of the profits for the puarter ending 31st December, 1877. A dividend of 3s. per share on the Six per Cent. Preference Shares, less income tax, for the quarter ended 31st March, 1878, will be paid on the same date. The register of transfers will be closed from the 8th to the 15th April, both days inclusive. The half-yearly interest on the Six per Cent. (1883) Debentures will be paid on the 15th April, at the banking-house of Messrs. Glyn, Mills, Currie, & Co., 67, Lombard-street.

The directors of the Eastern Extension Australasia and China Telegraph Company (Limited) announce a dividend for the quarter ended 31st December, 1877, of 2s. 6d. per share, free of income tax, making with previous payments a total of 5 per cent. for the year 1877, carrying £30,905 to reserve.

The directors of the Great Northern Telegraph Company announce their intention of paying a final dividend of 2s. 9d. per £10 share—in addition to the 5 per cent. already paid—to carry forward £19,277 and to add £30,539 to the reserve, which fund will then stand at £85,542.

The directors of the Western Union Telegraph Company notify that a dividend of 1½ per cent. will be declared, and a balance of 136,743 dols. carried forward. The returns for the quarter appear to be fairly satisfactory.

We notice an advertisement in a contemporary, signed S. F. Van Choate. We may probably direct attention to this in our next issue.

It is announced that Mr. John Hollocombe, a member of the Platino-Brazilian Telegraph Company's Shareholders' Committee, has sailed for Rio de Janeiro, in order to carry the necessary resolutions for the transfer of the Company to London. Telegraphic advices have been received from the board in Rio that the transfer of the Company will be passed at the meeting of shareholders, to attend which Mr. Hollocombe has gone to Brazil. As Mr. Pender is the chairman of the committee in question, it may be assumed that the transfer means something. Are the fortunes of the shareholders of the Western and Brazilian Company about to be realised?

THE TELEGRAPHIC JOURNAL.
Vol. VI.—No. 125.

ELECTRIC LIGHTING.

The last words of the expiring poet Goëthe are said to have been a cry for "more light." We remember hearing, a few years ago, the eminent Scotch divine, Principal Caird, preach one of his famous sermons to the students of Glasgow University. It was a dismal November Sunday, and the college chapel was dimly lit by coal gas, half-turned on. As the orator waxed mightier in the pulpit, the winter day waned, and the darkness deepened. When at the climax of his eloquence, he suddenly rehearsed the closing prayer of Goëthe, "More light—more light!" In an instant the chapel blazed with light. The janitor, a matter-of-fact old Scotchman, had promptly turned on the gas. This practical answer somewhat discomfitted the preacher; but it was none the less appreciated by the congregation.

If in these times, as some think, the higher spiritual light which Goëthe sought is waning, and becoming more and more uncertain, the same cannot be said for that material light supplied by the Macpherson. A source of illumination, of a power and brilliancy before unheard of, and rivalling the beams of the sun himself, is already in our hands. The electric light, as M. Jamin pointed out, at one of the recent conferences of the Sorbonne, which correspond to our Friday evening meetings at the Royal Institution, has now entered its practical stage. It has been so fully developed now that in regard to cost, convenience, and effectiveness, it completely eclipses, for certain purposes, the ordinary coal-gas in general use. These purposes are the lighting of large areas by a few powerful lamps. As yet, the electric light cannot be said to be fitted for the lighting of streets and private dwellings. In a practical sense it is not so divisible as gas, and cannot be so easily conducted into all the multifarious ramifications of houses and cities. For the present, at least, gas will hold its own in this department; but for the lighting of factories, large commercial establishments, warehouses, shops, and wide public thoroughfares, the electric light is ready to be adopted with profit and advantage. "Gas," said M. Jamin, "should be the retail purveyor, electricity the wholesale merchant."

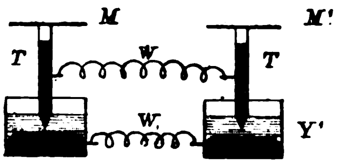
Besides its cheapness, the electric light is superior to gas-light in many respects for such purposes. It has been complained that the light is too white and ghastly. It would be as reasonable to quarrel with daylight itself as to quarrel with it on this account, for the electric light is the nearest approach we have made to the perfection of sunlight, and it is only because we have been so long accustomed to the sickly yellow hue of gas that we cannot yet fully appreciate the purer brilliance of electricity. Under the electric light the most delicate colours preserve their tints, and this fact especially recommends it to dyers, and also to manufacturers of cloth, for with it even the darkest colours can be woven by night as well as by day. The safety of the electric light against fire is another point in its favour. No lucifers are required to kindle it; each lamp is enclosed in a glass shade, and takes of itself the place of fifty or more scattered jets of gas. This consideration has caused insurance companies to insure works lit by electricity at a lower rate than the ordinary. The electric light is healthier than gas, inasmuch as it consumes little or no oxygen, and consequently gives off no foul and pernicious exhalations of carbonic acid, and other poisonous gases. There is little or no burning in connection with it, and therefore, it does not raise the temperature of the factory. It is handy, for the necessary apparatus, magneto-electric machines, lamps, and connections, can be set up in a very short time; and the due lubrication and supply of carbon wicks, are the only further cares necessary. It has been objected to the electric light that it is too intense and not sufficiently diffusive, that it throws black shadows and is therefore unsuited to the illumination of factories, where there is a multiplicity of shafts, pulleys, and belting. But this defect, if it be a defect, can be overcome by the use of reflectors, or even by whitening the walls and ceilings, so that the light is mixed up and blended into a soft diffused radiance, which fills the whole apartment uniformly and casts no shadow at all. The cost of maintaining the light, apart from the initial expenses of installation, is at present only about one-fifth of the cost of gas.

On the Continent, and especially in France and Germany, where the machines of Gramme and Siemens have originated, the application of the electric light to large buildings, railway stations, and public places, is proceeding apace. England, which is considered by our Continental neighbours to be one large workshop, is somewhat behindhand in the matter; nevertheless, owing to our busy industries, and to the naturally obscure character of our remarkable climate, and the retiring disposition of our sun, England is a country which has more to gain by adopting the electric light than any other. The recent Trinity House trials of dynamo-electric

machines clearly demonstrated that of those experimented upon, the Siemen's form was the best. But further, and probably more crucial, because more extensive, experiments are, we believe, about to be made at the forthcoming Paris Exhibition, with a view of determining the relative advantages of existing machines. It appears to be agreed that all the latest forms are capable of outdoing gas-light for illumination on a large scale; and it only remains to discover their order of merit. These trials will be witnessed by visitors from all parts of the world, and no doubt the subject of electric lighting will receive an impulse from such a display of its capabilities. Let us hope that the impulse will be felt in England.

BREGUET'S TELEPHONE.

M. Breguet has invented an entirely novel telephone, based on the principle of Lippmann's electro-capillary electrometer. The transmitter and receiver are exactly alike, and each consists simply of a glass vessel containing a layer of mercury over which floats a layer of acidulated water. Into this water dips the point of a glass tube containing mercury. The upper part of the glass tube contains air, and may be open to the



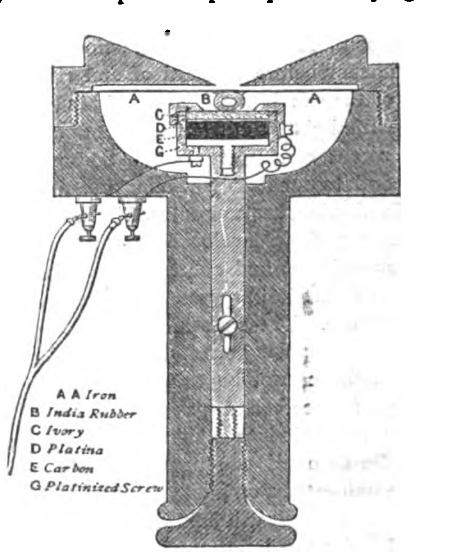
atmosphere or closed by a plate or diaphragm capable of vibrating. The circuit is formed by connecting up the mercury in the tube of the transmitting telephone with that in the receiver, and also the mercury in the vessel of the transmitter with that in the receiver. When one speaks over the top of the tube of the transmitter, the vibrations of the air are transmitted through the mercury to the point of the tube where the mercury makes contact with the acidulated water of the vessel by the fine capillary bore of the tube. Here the electro-capillary action takes place, the vibratory motions of the mercury generating electro-capillary currents which traverse the circuit to the receiver, and by a reverse process reproduce the air vibrations at the top of the tube of the receiver. M. Breguet says that this telephone, unlike Professor Bell's, is capable of reproducing not only oscillatory motions of the air, but of reproducing the exact range of the most general movements of the vibratory plate. A portable form of this instrument, constructed by M. Lippmann, consists of a fine glass tube several centimetres long, containing alternate drops of mercury and acidulated water, so as to form an electro-capillary series. It is sealed at the ends, by which two platinum wires make contact with the terminal mercury drops. A *rondelle* of firwood is fixed normally to the tube by its centre, and gives a larger surface for the voice to act against, so as to furnish more motion to the tube when it acts as a transmitter, and be easily applied to the ear when it is a receiver.

M. Breguet claims for this telephone, that it will act through submarine cables with instantaneous effect, because it will only establish *variations of potential* at the sending end of the line, and, unlike other telephones, will not generate *currents* to flow through the line. But this claim does not appear to us to be justifiable, since currents must result in the line from the variations of potential set up, and if there is to be any communication at all, they must travel throughout the length of the cable from end to end.

EDISON'S TELEPHONE.

Described by G. B. Prescott in *Scribner's Monthly*.

Mr. Thomas A. Edison, of Menlo Park, New Jersey, has invented a telephone which, like that of Gray, is based upon the principle of varying the

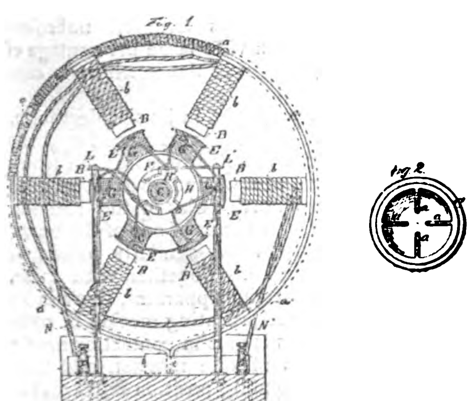


strength of a battery current in unison with the rise and fall of the vocal utterance. The problem of practically varying the resistance controlled by the diaphragm, so as to accomplish this result, was by no means an easy one. By constant experimenting, Mr. Edison at length made the discovery that, when properly prepared, carbon possessed the remarkable property of changing its resistance with pressure, and that the ratios of these changes, moreover,

corresponded exactly with the pressure. Here, then, was the solution; for, by vibrating a diaphragm with varying degrees of pressure against a disc of carbon, which is made to form a portion of an electric circuit, the resistance of the disc would vary in precise accordance with the degree of pressure, and consequently a proportionate variation would be occasioned in the strength of the current. The latter would thus possess all the characteristics of the vocal waves, and by its reaction through the medium of an electro-magnet, might then transfer them to a metallic diaphragm, causing the latter to vibrate, and thus reproduce audible speech. The figure shows the telephone as now constructed by Mr. Edison. The carbon disc is represented by the black portion, E, near the diaphragm, A, A, placed between two platinum plates, D and G, which are connected in the battery circuit, as shown by the lines. A small piece of rubber tubing, B, is attached to the centre of the metallic diaphragm, and presses lightly against an ivory piece, C, which is placed directly over one of the platinum plates. Whenever, therefore, any motion is given to the diaphragm it is immediately followed by a corresponding pressure upon the carbon, and by a change of resistance in the latter, as described above. It is obvious that any electro-magnet, properly fitted with an iron diaphragm, will answer for a receiving instrument in connection with this apparatus.

WESTON'S DYNAMO-ELECTRIC MACHINE.

This convenient machine, the invention of Mr. Edward Weston, an American electro-metallurgist, has, during the last two years in America been gradually taking the place of the large and troublesome batteries hitherto used in electrotyping; and an agency has recently been opened for it in London at 41, Queen Victoria Street. It is small and compact, easy of management, requiring only to be connected up by a belting to a source of rotary power, and yields a uniform current, capable of depositing a shell of copper from type in from two to two and a half hours, the shell being homogeneous in texture, and free from pin-holes. Nickel-plating is an industry which is coming more and more into use, owing partly to its silvery lustre and the low cost of the metal, but principally to the impetus given to it by the introduction of these machines. The recent discoveries of nickel ore in New Caledonia will doubtless tend to accelerate its extension still more.



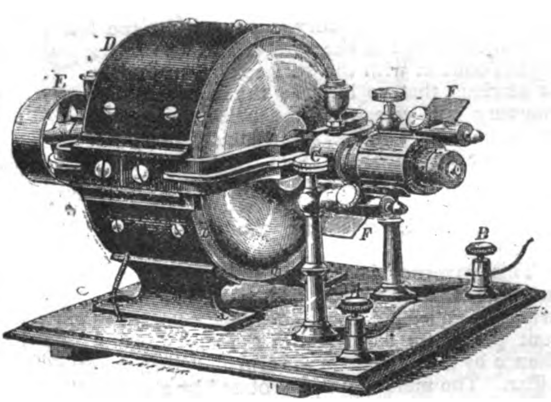


Fig. 1 represents the internal arrangement of the machine. An iron ring, or cylinder, A, forming the outer case, is fixed upon a wooden base. From the interior of this ring a number of magnets, B, B, B, project at equidistant intervals, all pointing to the centre of the ring. These magnets consist of a core of iron, to which are fastened a number of thin, tempered steel plates, the whole being wound with insulated copper wire, *b*, *b*, *b*. They are connected up together, so that the poles are alternately north and south. In the central space between the poles of these magnets, a revolving shaft, *c*, carries a series of armatures, E, E, E, made in segments. These armatures are formed of iron cores, wound with wire, G, G, G. The outer projecting ends, E, E, E, are thin lozenge-shaped pieces of iron, so arranged that when they are simultaneously revolved by the turning of the shaft they will pass very close to the inner poles of the electro-magnets, B, B, B, but without touching.

When the shaft, *c*, which carries the armatures, G, G, G, is revolved rapidly past the electro-magnets, B (which have been previously charged), currents are induced in the coils of the armature, and, as these currents are alternating, a commutator, H, H′, fixed upon the shaft, is adopted to render them uniform. Two springs, or brushes, L, L′, are used along with this commutator to pick up the currents from it. They are made of very thin, hard rolled sheet copper, silver plated, in order to secure good contact without much friction. They are silver plated in order to prevent oxidation of the separate strips, and so secure a connection between the whole. These springs are fixed in adjustible clamps, supported on brass pillars.

The operation of the machine is as follows:—If the machine be new, the current from a battery or other source of electricity is first passed through the outer electro-magnets in order to magnetise the steel plates of the core feebly, but permanently. The shaft and armature are then rotated by means of a belt, from any convenient source of power; weak

currents are thereby induced in the coils of the armature; these are rendered similar in direction by the commutator, and gathered up by the brushes or springs, L, L'. From the two pillars they are led by wires, N, N, to the coils of the electro-magnets, which they further enrich with magnetism. This intenser magnetisation of the electro-magnets induces intenser currents in the rotating armature, which again flow to intensify yet more the inducing electro-magnets, and so on, according to the well-known principle of mutual accumulation. To utilise the currents from such a machine, it would simply be necessary to place the work to be done in circuit with the electro-magnets and armatures, so that the currents induced in the armatures may pass through the work as well as the electro-magnets. But this mode of employing the currents is quite unsuited to electro-metallurgy, as the secondary currents resulting from polarisation of the electrodes in the depositing vat would, when the speed of the machine fell below a certain point, reverse the polarity of the electro-magnets and the direction of the current, thereby undoing what had been previously done, and defacing the electrotype.

The device for preventing this evil effect is a special feature of the Weston machine. An upright pillar of brass, iron, or other good conducting material is fixed on the base of the machine. On the top of this pillar is placed a cup, which can be rotated round its vertical axis by means of a belt from the shaft of the machine. This cup has ribs or paddles on the inner side of its lower half as shewn in fig 2. At a short distance from this pillar, is placed another upright pillar parallel with the first, but having its end bent over at right angles towards the first in such a way as to project over the top of the cup. From the end of this arm, or bracket, a copper wire with an amalgamated point is made to dip into the cup. The length to which this wire can dip down into the cup is adjustible by a screw. A small quantity of mercury is poured into the lower half of the cup, and the wire adjusted so that it just makes contact with the surface of the mercury. It is obvious that so long as the cup is at rest, the mercury will remain at the bottom, and the wire and cup will be in metallic contact. A circuit can therefore be established through them. But if the cup be rotated at a certain speed, the mercury will rise in it, and the contact between wire and cup will be broken. In this way the circuit would be interrupted.

This governor is inserted in the circuit of the machine, that is to say, the circuit formed of the armature coils, and the electro-magnets. The current passes up one pillar to the mercury cup and thence by the wire along the arm and down the other pillar. The mercury cup is rotated by a connection from the shaft of the armature, and there is a certain speed of rotation which causes the mercury to rise in the cup, breaking contact with the wire. In this case the current could then flow through an outside circuit consisting of the work to be done, if it were connected up to the pillars. Conversely, when the shaft of the machine, and consequently the cup falls to a certain speed, the connection between the cup and wire would again be completed, and the current would be short circuited past the external working circuit. By this contrivance it is obviously impossible for the reverse current from the electrodes of an electro-typing vat to reverse the polarity of the electro-magnets when the speed of rotation falls below a certain point, because such currents would not be allowed to enter the electro-magnets at all; they would be short circuited through the wire and mercury and would speedily exhaust themselves.

Figure 3 represents the external appearance of this machine. No. 4 machine is largely used by manufacturers of silver ware and nickel, copper, and bronze goods. It is 16 by 22 inches in the base, weighs 350 lbs., and costs £100. It can be driven at a speed of 800 turns per minute by ¾ of a horse power.

VARLEY'S MAGNETO-ELECTRIC MACHINE.

The principle and chief features of novelty in this machine mainly consists in maintaining actual or nearly actual contact between the armatures and poles of the inducing magnets. The magnets themselves, together with the intermediate cores, are surrounded by helices, and form complete magnetic circuits, so that the magnetic poles of the permanent or electro-inducing magnets have their respective north and south poles continuously, or nearly continuously, closed notwithstanding the movement of the armature or armatures, but which armature or armatures when rotated or moved to or fro along the iron ring or link included in or forming part of the continuous magnetic circuit, alters the direction of the magnetic conduction through the inducing cores surrounded by electric conductors; the effect of which alteration is to generate electricity in the conductors forming the helices. The armatures being in actual or nearly actual contact with the inducing magnets insure a more perfect magnetic conduction through the intermediate cores with which the inducing magnets form an unbroken magnetic circuit, so that a very large per centage of work done in giving motion to the machine is converted into electric energy.

A machine on this principle, in its simplest form, consists of two horse-shoe magnets placed opposite one another, and with two soft iron cores, on which coils of covered wire are wound, placed between their poles. The two north poles of the magnets are in contact with the two ends of one of the cores, and the two south poles are similarly placed in relation to the other core. Together with these, which are fixed parts of the apparatus, there is an armature to which a reciprocating motion is communicated, which places it first in contact or nearly so with the two poles of one magnet, and then transfers it to a corresponding position in respect to the other magnet. To increase the area of the surfaces in contact or close proximity, the faces of the magnets and of the armature may be grooved. The armature may also be made double, so that the poles of the magnets may be received between its two parts. The attraction of the magnet for the two parts of the armature will then balance each other, and by a screw adjustment the surfaces of the armature may be brought very close to the surfaces of the magnets without giving rise to friction. In place of a reciprocating armature a rotating armature may be employed, so formed as to connect the north

pole of one magnet with the south pole of the other, and as it rotates to couple the poles alternately.

In Figure 1, M and M¹ are horse-shoe magnets; permanent magnets are represented but electro-magnets are also available. Between the magnets and in with them are two cores of soft iron wound with coils of insulated wire C, C¹; they form part of the circuit or circuits in which the electricity generated by the apparatus is transmitted. N, S, and N¹, S¹, mark the poles of the magnets M and M¹. O, O, are guides made of gun metal in which the rod D is free to slide to and fro; it has upon it the armature of soft iron marked A. A reciprocating movement may be communicated to the armature between the guides O by connecting the rod D directly or indirectly with a steam engine or other motor. It will be observed that in this arrangement no reversal of the magnetism in the armature A takes place.

Figure 2 is an end view of the armature A shewing how it is grooved into the horns of the permanent magnets M, M¹. Figure 3 shews the rotating armature arrangement. The armature is mounted upon a rotating axis D, and as it revolves it alternately closes the pole N with S¹ and N¹ with S. In this arrangement the magnetism in the armature A is reversed in each rotation, and the armature carries a coil C², so that electricity will be generated in the circuit of which this coil forms part. An ordinary rotating commutator may be included in the circuit and the electricity can then be employed to excite the magnets M, M¹, when electro-magnets are employed.

FIG. 1.

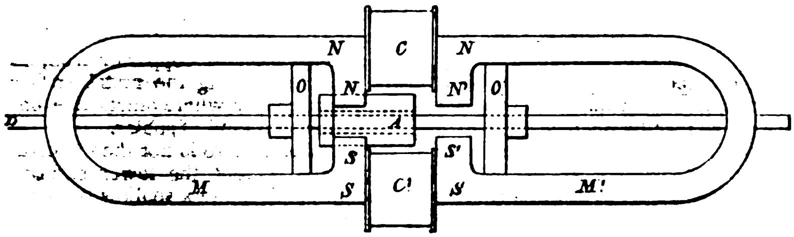


FIG. 3.

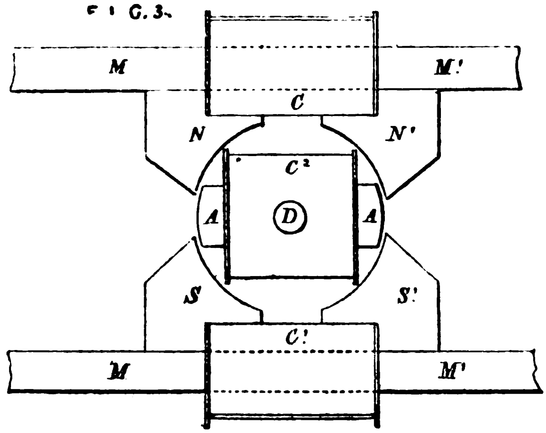
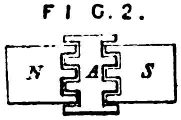


FIG. 2.



THE LIGHTNING ROD.

By R. J. MANN, M.D., F.R.A.S.

In a paper read before the Society of Arts, Dr. Mann gives the following summary of the conclusions he has arrived at with reference to the construction of lightning rods:—

1. The copper rope, or rod, employed as the main stem of a lightning conductor, should in no case have a diameter of less than four-tenths of an inch.

2. A rope, or rod, of four-tenths of an inch in diameter is not large enough for the protection of buildings that are more than 80 feet high. The resistance offered by a conductor of any given diameter increases with its length. Long conductors, therefore, require to be of larger size than short ones.

3. For every additional 80 ft. of height, or of extent, a second rope, or rod, of the same transverse dimensions must be added, or the sectional area of the single rod must be increased in a similar degree.

4. It is of no practical importance whether the conductor possess the form of a rope of twisted wire, or of a rod, provided it be of sufficient dimensions for the work which it has to perform.

5. If a cylinder, or pipe, is used instead of a rope, or rod, it must be considered as furnishing the same conducting capacity that it would have if slit up along one side, and opened out into the form of a flat band.

6. Galvanised iron may be used as a conductor

instead of copper, but it must have considerably larger size, because iron is of inferior conducting capacity to copper. Increased size can quite compensate for inferior transmitting capacity.

7. An iron rope, or rod, to be equally efficient, must be rather more than double the width of a copper rope or rod. In exact figures the proportional diameters needed is as 6·7 to 2·5. The conducting capacity of iron is five and a-half times less than that of copper, or, in more exact figures, as 14 to 77.

8. A galvanised iron rope conductor should, in no circumstance, be less than eight-tenths of an inch in diameter.

9. When a strip, or tape, of copper, is used in place of a rope, or rod, it should be in no case less than three-quarters of an inch broad, and one-eighth of an inch thick. Such a strip contains a sectional area of a tenth of a square inch.

10. Galvanised iron, when used in the form of a strip, should be four inches wide, and an eighth of an inch thick. Such a strip would contain a trifle more than half a square inch of sectional area.

11. A lightning-rod must be absolutely unbroken, or of continuous length from end to end.

12. When metallic water-pipes, or other similar stretches of metal forming part of the structure, of an edifice, are made to do service as lightning conductors, all joints must be carefully made good by solder, and tested afterwards to ascertain the sufficiency of their conducting capacity. Without this precaution, the arrangement is liable to be a source of danger, instead of a means of safety.

13. It is quite unimportant how a lightning-rod is attached to a building. It does not need insulating fastenings; ordinary metal clamps of any kind may be quite safely employed, provided the rod be of good conducting capacity, and otherwise efficient.

14. The rod must be terminated above in metal points, well projected up into the air.

15. The terminal points may be made either of copper, or iron, but they must be tapered out very gradually, and be perfectly sharp. An alloy composed of 835 parts of silver, and 165 parts of copper, forms an excellent material for tipping the points, because it enables these to preserve, for a long time, their sharpness under the circumstance of exposure to moist air. The silver tips should be made about two inches long, and be firmly screwed into the termination of the conductor.

16. The air-terminal of the conductor should be branched out into several points. Multiple points —or aigrettes, as they are termed—of this kind, are now made in copper, of very good form, by all the best electrical engineers.

17. The larger the building that has to be protected, the more points, or clusters of points, should be used. In the case of buildings of any considerable extent the conductor itself must be branched out to all parts, and each branch must end in its own projecting tuft of points.

18. Terminal points should project into the air, at least eight feet beyond the building itself.

19. The general idea may be kept in mind that lightning conductors approximately protect a conical space around them, whose base is four times as wide as the conductor is high. This principle, however, is not an infallible one, and it must not, therefore, be too implicitly relied upon. Whenever any parts of a building approach towards the limiting surface of such a conical space, additional points should be fixed there, and be brought into connection with the general system of the conductor.

20. The bottom of the conductor must be carried down into the earth, and be connected with it by a surface-contact of large extent.

21. About the best earth-terminal that can be contrived, consists in connecting the end of the conductor with the iron main of a gas-service, or water-service. The end of the conductor should be attached to a broad piece of copper or iron, and this should be laid close along the metal surface of the main underground, or, where practicable, be even attached to it by some kind of solder.

22. Where there is not the opportunity for adopting this expedient, the lower end of the conductor should be placed in a shallow trench, opened out 20 feet in the moist ground, and be buried along in it to the end, and be also well packed round with gas coke, broken into small pieces, before the trench is covered up with earth.

23. Plates of copper, or iron, may be used as earth-terminals, if this be preferred. The plate should not then, however, in any case, furnish less than two square yards of earth contact, reckoning both sides, and it must be carefully rivetted and soldered to the conductor, and be surrounded with broken coke, before it is buried up in the earth.

24. When the earth is unavoidably dry, the earth-contacts of the conductor must be made proportionally large. Abundant size may be so managed as to compensate for the disadvantage of dryness.

25. With dry earth-contacts, lightning rods may be a source of danger instead of safety, if this precaution be not observed. The only means by which it can be ascertained whether a dry earth-contact has been made large enough is the employment of the galvanometer. This test should never be omitted when the conductor terminates in a dry soil.

26. The danger of a lateral discharge from a lightning conductor diminishes with its capacity. A large well-pointed and well-grounded conductor will convey a very powerful discharge to the earth without the slightest tendency to strike through any object external to the rod. A small and imperfectly appointed conductor, on the other hand, is always prone, during the trasmission of lightning, to flash off some portion to surrounding objects.

27. The capacity of a conductor may practically be increased in three ways to ensure this efficiency and safety :—1. By the employment of larger ropes or rods; 2. By a more abundant service of points; and 3. By amplification and improvement of the earth contact.

28. The proof that a conductor has been made capacious enough by the judicious employment of these means, is furnished by the magnetic needle of a galvanometer not being materially deflected when a galvanic current is passed through the conductor to the earth.

29. All large masses of metal contained in a building should be metallically connected with the lightning-rod, unless when such are liable to be occupied by living people during a thunderstorm,

as in the case of an iron balcony fixed outside a wall in front of a casement; it is then better that such masses should not be connected with the conductor, because, under such circumstances, persons standing upon them would be in less danger of being struck. When they are connected with the conductor there is always some risk of persons standing upon them furnishing a path for the lightning to the conductor.

30. The best method of connecting masses of metal with a conductor is by closed circuits. That is a connecting metallic band should proceed to them from two different parts of the conductor.

31. Soft metal gas-pipes must never be allowed to run anywhere near to a lightning conductor, because there is always danger when they are so placed of some part of the discharge deviating from its proper route to avail itself of the good earth-contact furnished by the expanded mains of the gas supply, and in doing so of melting the small fusible gas-pipe and setting fire to the gas.

32. Zinc or iron pipes on the tops of chimneys are always to be regarded as masses of metal that are to be brought into connection with the conductor.

33. Lofty chimney shafts may always be satisfactorily protected by a single conductor. Care must, however, be taken that the size of the conductor is adequate for the height, and the top of the shaft must be entirely encompassed by a bar or parapet edge of metal, and points must radiate from it on all sides into the air.

34. In the case of manufactories where corrosive vapours are emitted from the chimneys, copper or iron terminals should be soldered into leaden tubes, and a subordinate service of points should be added at some lower level, where they would not be liable to be affected by the corrosive vapours.

Reviews.

Pocket-Book of Useful Formulæ and Memoranda for Civil and Mechanical Engineers. By GUILFORD L. MOLESWORTH. Nineteenth edition, with a valuable contribution on telegraphs by R. S. BROUGH, Indian Telegraph Department, and PAGET HIGGS, L.L.D. E. and F. N. Spon, Charing Cross, London.

THAT this handy pocket-book should have reached a nineteenth edition is a decisive proof of its merits. The addition in the later editions of a section devoted to telegraph construction adds very much to the value of the work; but we must confess that some portions of the matter in this section are of a perfectly useless nature. Of what use, for instance, a number of formulæ on the Catenary can be to the telegraph engineer is beyond our comprehension. We do not hesitate to say that Messrs. Brough and Higgs could not bring forward a single instance in which such formulæ have proved of the slightest practical value to the telegraph engineer. The example we have picked out is by no means an isolated case, as we could point to many other instances if necessary. It is perfectly true that formulæ may appear to be of no value when such is not really the case, and this is very often the consequence of the extremely unpractical way in which such matters are put before the seeker after information. That theory may be of use, it is essential that it be put in such a form that it can be of practical value, and it is a pity that skilled mathematicians do not exercise their skill by explaining how their formulæ may be made useful; if they did so we should hear less of the cry, "Very beautiful in theory, but practically quite useless."

Elementary Text-Book of Physics. By J. D. EVERETT, M.A., D.C.L. Blackie and Son, Glasgow and Edinburgh.

THIS little book is primarily intended as a text-book for elementary classes of physics, and is well adapted for that purpose. The chapters which deal with electricity, although short, are well written, and put the subject clearly before the reader.

Notes.

ATTENTION has been called to what may be the earliest musical telephone we are acquainted with. *Dingler's Polytechnischer Journal* for 1852, and *Bottger's Polytechnischer Notisblatt* for 1853, contain some account of it. It was the invention of M. Paterma of Prague, and was a keyed instrument which, by a galvanic current, set a small iron plate into vibration as soon as the hand left the key. Each key gave a different note, and a similar instrument at a considerable distance was caused, by an electrical communication, to give out the same music.

IN Jersey City, U.S., a telephone line has been erected between the County Court-house and a central office, to enable the lawyers engaged at the court to communicate with their offices.

THE Charles B—— mentioned in Count du Moncel's "Treatise on Electricity," as having conceived the idea of a speaking telephone in 1854, is M. Charles Bourselle, sub-inspector of telegraph lines at Auch.

THE telephone is causing some excitement in Spain. Large numbers are being manufactured at Barcelona, and conversation has been carried on between that city and Saragossa, a distance of 364 kilometres. The sounds were heard most distinctly at Barcelona, where the speaker stood in a closed sentry-box or turret, which excluded extraneous noises. For so great a distance, it was found necessary to give a considerable resistance to the bobbins of the telephones.

A MAGNETO-ELECTRIC MACHINE, included in the telephone circuit, operates as an alarm; for on turning the handle, a series of comparatively loud taps can be heard in the telephones.

TALKING has been carried on by employing the water and gas pipes for a circuit between two houses thirty yards apart.

THE TELEPHONE AS A CURRENT DETECTOR.—Mr. Herbert Tomlinson writes to *Nature*, March 14th, to say that he has been able to apply the telephone to the measurement of resistances by a Wheatstone bridge. The telephone was put in the stead of the galvanometer, and its circuit was rapidly interrupted by the electro-magnetic apparatus of an electric bell. He found that with a little practice, it was possible to compare two resistances of about two ohms each within at least $\frac{1}{1000}$ of the true ratio. As the sliding contact was moved, so as more nearly to equalise the two resistances compared, it was curious to hear the sound dwindle down, until only a slight "uneasiness" was felt in the ear. By employing a tuning-fork to vibrate constantly by electricity as the current breaker, and a Helmholtz resonator to intensify the sound, Mr. Tomlinson anticipates much greater accuracy in the test. This substitution of the sense of hearing for that of sight in making electrical measurements, may in special cases be useful.

ELECTRIC CLOCKS.—A correspondent of the *Scientific American* proposes to employ the Bell telephone principle of induced currents to the control of clocks by one standard time-piece. Under the pendulum of the standard is to be placed a magnet, wound with coils of wire, in circuit with a similar arrangement at each of the other clocks, so that when the iron bob of the standard pendulum swings past the coils at every stroke, a current will be induced in them, which will traverse the entire circuit, and operate on the pendulums of the dependent clocks, by means of their electro-magnetic coils and iron bobs.

MR. J. E. H. GORDON, in a letter to *Nature*, points out that the telephone may be used to measure the number of interruptions in a rapidly intermittent circuit by the note which it gives out when inserted in it.

AT the forthcoming Paris Exhibition, according to the *Journal of the Telegraph*, Mr. T. A. Edison will exhibit telegraph instruments; Mr. Elisha Gray, telephones; Mr. Meritt Gally, telegraph instruments; the Weston Dynamo-Electric Machine Co., electro-plating apparatus; Mr. C. H. Pond, of New York, an electric gas lighting machine; and Mr. A. G. Day, of New York, Kerite insulated telegraph wires and cables. It is not expected, however, that the American display will at all do justice to the extraordinary fertility in electrical inventions which has been exhibited of late years in the United States.

A COMPANY has been started in Paris, with a capital of £14,000, for the purpose of introducing electric lighting.

THE Adelaide to King George's Sound land-line in Australia has been completed, thus connecting all the Australasian colonies together.

FLOATING TELEGRAPH STATIONS ON THE COAST.—At a meeting of the United Service Institution on March 29, Major Weatherhead suggested that floating telegraph stations should be established thirty or forty miles from the coast, to act as offices to which our cruisers might resort to give information of an enemy's movements, and thus save the time and expense of special despatch vessels. The idea of having floating stations is by no means new. About seven years ago one was established by the Mid-Channel Telegraph Co. on the "Admiralty Patch," a shoal about 70 miles off the coast of Cornwall; but the continual breaking of the cable through the rolling and pitching of the moored vessel (*The Brisk*) necessitated the winding-up of the company, and we believe no attempt has since been made to practically revive the scheme.

TELEGRAPHERS' PARALYSIS.—This peculiar nervous affection is casuing some alarm at present amongst operators in America, where it appears to be unusually prevalent. It is a numbness and paralysis which affects the thumb, hand, wrist, and even forearm of the operator's right or keying hand, and positive pain is felt in attempting to handle the key when afflicted by it. It is unquestionably due to overstraining of the nerves and muscles in the rapid, minute, and monotonous motions of signalling; and is generally cured by rest. Its greater frequency in America than in Europe seems to be due to the "space" letters of their alphabet, and perhaps to the longer hours that American operators remain on duty. It appears to us that the happy mixture of dots and dashes, long and short signals in the Morse code, as it is used in England and the Continent, is calculated to prevent paralysis, for every dash is a brief rest to the hand. The matter has become so serious in America that there is a talk of introducing a a new code to replace the Morse as there practised. It would certainly be a safeguard against paralysis if every operator would learn to signal, at least moderately fast, with his left hand as well as his right. He could then occasionally rest the right, and perhaps, more expert hand, thus giving it time to recover its full vigour before any over-stressing had taken place. This disease in question excited some discussion in England several years ago, but it appears to have died out of late, since we now hear nothing of it. We should be glad to receive any information on the subject from English clerks, or others, who have it to give, for it may prove useful to American telegraphers. Have the Post Office hours of duty anything to do with its apparent disappearance from among us?

ACCORDING to *Engineering* the Government of Queensland has declined an offer made by Messrs. Siemens Brothers, to lay a duplicate cable between Queensland and Singapore for £700,000. Several new land lines are in course of erection in that colony.

THE longitude of the principal South American cities Pernambuco, Bahia, Rio Janeiro, Buenos Ayres, and Valparaiso, are being determined by the officers of the U. S. Hydrographic Office, by aid of the Brazilian

Submarine Telegraph Company's cables from Lisbon to Pernambuco.

M. JABLOCHKOFF, by means of large condensers, formed of sheets of tinfoil alternating with sheets of taffeta silk soaked in gutta-percha, is able to distribute the electricity from a single source to several lamps, and it is said that the whole light from the lamps is at least double that from a single lamp fed from the same source.

ALUMINIUM is stated to be more susceptible of magnetic induction after the hammering process necessary to condense it after being cast.

ST. ELMO'S FIRE.—The rare phenomenon of St. Elmo's fire was observed at several localities in the Harz Mountains during the past month. At Blankenburg it occurred at a temperature of $+ 0\cdot5°$ C. and pressure of 721·5 mm., after a series of storms. The air was so laden with electricity, that canes held aloft emitted from their points light blue flames five inches in length and three in breadth. In Döblitz the phenomenon occurred in the midst of a storm, half snow and half rain, when the ends of the branches in an entire grove were surmounted by flames from four to five inches in length.—*Nature.*

M. JAMIN, the eminent French physicist, has contributed a long article on electric lighting in a recent number of the *Reveu des Deux Mondes.*

EFFECTS OF PLANTÉ'S RHEOSTATIC MACHINE.—The effects produced by the rheostatic machine which we described a short time ago in the TELEGRAPHIC JOURNAL, are, says M. Planté in a note to the French Academy of Sciences, similar to those from electric machines and induction coils, but present certain points of dissimilarity worthy of mention. M. Planté studied them by means of machines composed of 10, 30, 40 and 50 mica plates charged with a secondary battery of 800 couples. With a ten plate machine making 15 turns per second, a series of brilliant sparks from 13 to 14 millimetres long were obtained, succeeding each other at the rate of 30 per second, accompanied with a crackling sound. On turning the machine slowly, so that few sparks passed, they became very sinuous, and when the machines with 30 and 40 plates were employed, these sinuosities raised and lowered themselves above and below the straight line jointing the discharge points. But on quickening the speed of the machine the track of the spark became more constant for each position of the points. When the points were inclined to each other at an obtuse angle, the spark issued in a track of fire straight from the positive point, raised itself above the negative point, and curved towards in a hook which displayed numerous sinuosities. The brushes formed by the discharge, when the distance between the points are increased by 1 or 2 millimetres, take the same course. The length of the sparks appear to increase in simple proportion to the number of condenser plates. Owing to the greater quantity of electricity in play, vacuum tubes are more brilliantly lit up by it than by electric machines, and when it is rapidly turned they are as vividly lit as by an induction coil. But there is an absence of the stratification observed in tubes lit by induction coils. The blue *sheath* which generally surrounds the negative pole is also absent, the light being purple throughout, as in the case of an induction coil with a condenser added. This effect is prevented by the high tension of the machine, for on charging the latter with electricity of lower potential, both the blue sheath and stratification appeared. The rheostatic machine gives in general all the effects of electric machines and induction bobbins untroubled by hygrometric variations of the atmosphere. M. Planté aims at obtaining these effects from a much smaller charging battery than 800 couples by increasing the number of condensers and making their plates thinner. With 50 of these condensers he has obtained sparks of 6 millimetres in length from a charging battery of 10 secondary couples, and can render a tube of rarefied air luminous by charging with from 30 to 40 secondary couples or 50 to 60 Bunsen cells. M. Planté made several experiments for the purpose of determining the time necessary to transform the dynamic electricity of the battery into the static electricity of the machine. For instance, he charged a secondary battery of 40 couples with 2 Bunsen elements for 15 seconds, and then put the machine in action by it. In order to draw off the whole of this dynamic electricity as a static charge through a Geissler tube, the machine had to be turned for more than a quarter of an hour. From this it follows that with a ten minutes' secondary charge, a tube can be kept illuminated for 6 hours.

EFFECT OF LIGHT ON SELENIUM. — Dr. Werner Siemens, after a long series of experiments, arrives at the conclusion that its sensitiveness to light is a peculiar property of this metal. Dr. Bornstein, on the contrary, has claimed this property to be common to a number of metals if not to all. Another German experimenter, Herr G. Hausemann, has also subjected Bornstein's results to proof, but without corroborating them. He employed a very sensitive galvanometer with a thermopile of iron and copper in circuit. By keeping the latter at a constant temperature, a constant current was maintained through the galvanometer, giving a steady deflection. When lengths of different metals were inserted in this circuit, and their resistance measured, no change of resistance could be detected as resulting from the impact of a beam of light. He, therefore, thinks that the effects which Bornstein obtained were due to other causes than light. Dr. W. Siemens suggests the use of selenium as a photometer for comparing the intensities of lights of different colour, the existing photomoters not being accurate enough for this purpose. When we judge two lights of different colours equal, our decision is purely subjective. The selenium photometer, on the other hand, would give definite results. The difficulty, however, is

to form a graduated scale for it in the first place. Dr. Siemens has attempted to construct an empirical scale, but as yet with only partial success.

Electro-motive Force of Liquid Galvanic Series.—It is known that the electro-motive force generated by the contact of liquid solutions is influenced by the degree of concentration of the solutions. Dr. James Moser, of Helmholtz's laboratory, has investigated the nature of this influence. Two glasses containing different solutions of the same salt were connected by a siphon which allowed the solutions to touch each other. An external circuit was formed by electrodes of the metal contained in the salt, in order to eliminate any chemical action. In all cases, a current was found to proceed across the siphon from the more dilute to the more concentrated solution. This current appeared in solutions of sulphate, nitrate, chloride, and acetate of zinc, sulphate and nitrate of copper, chloride of iron, acetate and nitrate of silver, &c. The electro-motive forces of these currents were observed by Poggendorf's method of compensation as modified by Du Bois-Reymond, and varied in strength from a few thousandths to one-fifth of a Daniell cell, the latter result being got from very dilute and highly concentrated solutions of zinc chloride. The series of electro-motive forces obtained from solutions of sulphate of zinc were as follows:

Between solutions of 15 per cent. of the salt and 30 per cent., the electro-motive force was ·005 of a Daniell cell.

Between 30 and 60 per cent. solutions, the electro-motive force was ·017 of a Daniell cell.

Between 15 and 60 per cent. solutions, the electro-motive force was ·021 of a Daniell cell.

By these currents proceeding from the weaker to the stronger solution, metal is dissolved in the weaker and separated from the stronger solution. Only when the solutions are of equal strength does the current cease. Dr. Moser is of opinion that the equivalent of the work done by the current is to be sought in the force of attraction between the salt and the water, which is perceptible in the heat generated on mixing different solutions of the same salt; and that the current itself is a reaction current against the migration of ions, just as the polarisation current is one of reaction against the decomposing current. When a salt is electrolysed, the solution becomes more concentrated at the anode, and more dilute at the cathode. Dr. Moser's experiments show that an electro-motive force then arises in opposition to that of the electrolysing battery. We are tempted to inquire whether this method of research could be utilised as a test for the saturation of solutions.

The Phonograph.—At a meeting of the Royal Society of Edinburgh, on March 18th, Professor Fleeming Jenkin, and Mr. J. A. Ewing, announced that the phonograph had enabled them to prove that all the elements of articulate speech are essentially reversible. By reversing the motion of the barrel of the phonograph, the sounds uttered to it are repeated in reversed order, but the individual parts of the sound remain unchanged. Thus when "ab" is spoken, and the instrument turned backwards, "ba" is heard. There is nothing remarkable in the fact that continuous sounds, such as those of the vowels, should be reversible, but it does seem very strange that the same should be true for such consonants as b, d, k, &c. This discovery affords a criterion of what constitutes a separate and individual element in any articulate sound; it is any part which is separately reversible, that is to say, which gives the same sensation of sound when spoken backwards or forwards. These reversible elements correspond, generally speaking, to the separate vowels and consonants, but some of the written symbols, such as I, correspond to at least two elementary sound sensations, while in other cases a single element is represented by more than one letter, as *th* and *ng*. The reversibility of articulate speech may be illustrated in a striking way by speaking a word or sentence *backwards* to the phonograph, and then reversing the motion of the instrument, when the words will be spoken in the natural way, except that the accent is usually ludicrously misplaced.

Mr. Edison at Home.—A reporter of the New York *Sun* recently interviewed the world-famous inventor of the phonograph, Mr. Thomas Alva Edison, at his residence, Menlo Park, New Jersey. "Menlo Park," says the *Sun*, "is a small place on the line of the New York and Philadelphia railroad, two miles north of Metuchin. Mr. Edison's manufactory stands forty rods west of the depot. A high bank shuts out the view from the car windows. The building is a long wooden structure, something like an old-fashioned Baptist tabernacle. It faces to the east. Nine lightning rods pierce the sky above it. A dozen telegraph wires are led into it by sentry-like poles connecting with the main line along the railroad. The front doors open directly into the office. The writer entered. A man sat at a table studying a mechanical drawing. An inquiry for Mr. Edison drew from him the words, 'Go right up stairs, and you'll find him singing into some instrument.' Climbing a flight of stairs, the writer found himself in a long room forming the second story.

"Professor Edison was seated at a table near the centre of the room. He looked like anything but a professor, and reminded one of a boy apprentice to a moulder. His hands were grimy with soot and oil; his face was entirely beardless, but sadly needed shaving; his black clothes were seedy, his shirt dirty and collarless, and his shoes ridged with red Jersey mud; but the fire of genius shone in his keen gray eyes, and the clean cut nostrils and broad forehead indicated strong mental activity. He seems to be always looking for something of great value, and to be just on the point of finding it. Unfortunately, he is quite deaf, but this infirmity seems to increase his affability and playful boyishness. A man of common sense would feel at home with him in a minute, but a snob or a prig would be sadly out of place.

Though but thirty-one years old, the occasional gleam of a silvery hair tells the story of his application."

The writer goes on to describe a rehearsal with the phonograph, and to give Mr. Edison's views of its capabilities.

It appears that a prominent American showman (possibly Barnum) has already taken steps towards the formation of a museum of wax figures, similar to Madame Tussaud's, but each having the gift of speech; and in the breast of the wax statue of the great American tragedian Edwin Forest are to be placed phonograph matrixes of his style as given by a clever mimic. Mr. Edison is reported to have said that if the last benediction of Pope Pius IX. had been copied by phonograph, every Roman Catholic on the earth might have heard it—" there was a fortune in it: these matrixes could have been sold at five dollars a-piece." It is a pity that American humour should so often lack good taste.

Another of the applications of the phonograph suggested will probably be new to our readers. It is proposed to place the diaphragm in steam whistles so as to talk like a calliope. The captains of ships at sea could thus talk with each other at a distance of two or three miles, and locomotives could be made to announce the names of railway stations before drawing up at the platform, in a voice loud enough to be heard by the whole train. This airophone, as Mr. Edison calls it, may yet be extensively adopted as an advertising medium, and within two years he expects to see it at the stores of Broadway calling out, "*New York Sun*, price two cents"—" Brandreth's Pills "—" Longfellow's Poems."

"How did you discover the principle?" asked the reporter.

"By the merest accident," said the professor. "I was singing to the mouthpiece of a telephone, when the vibrations of the voice sent the fine steel point into my finger. That set me to thinking. If I could record the actions of the point and send the point over the same surface afterward, I saw no reason why the thing would not talk. I tried the experiment first on a strip of telegraph paper, and found that the point made an alphabet. I shouted the words, 'Halloo! halloo!' into the mouthpiece, ran the paper back over the steel point, and heard a faint 'Halloo! halloo!' in return. I determined to make a machine that would work accurately, and gave my assistants instructions, telling them what I had discovered. They laughed at me. I bet fifteen cigars that the thing would work the first time without a break, and won them. I bet two dollars with the man who made the machine, and won that also. That's the whole story. The machine came through the pricking of the finger."

On the 1st inst., the construction of a subterranean telegraphic line between Frankfort and Strasburg was commenced. It is expected to be ready by the end of August.

The Plymouth Chamber of Commerce have decided to send a deputation to the Treasury, requesting that the subject of telegraphic communication with the new Eddystone lighthouse may be considered. As we pointed out in a leading article not long ago, it is doubtful whether such communication, however desirable, could be maintained for any length of time.

Direct telegraphic communication between England and the Channel Islands, which was interrupted about eight weeks ago, was restored on the 7th instant. The breakage was found to be twenty-five miles off Guernsey, and the condition of a large portion of the cable was found to be very bad.

It is notified that the Japanese Government has now adopted the word system of taxation. Telegrams by Eastern Telegraph Company for all parts of Japan except Nagasaki will, on and after May 1st next, be accepted at the rate of 12s. 2d. per word. For Nagasaki the rate will be 11s. 3d. per word. The rate by the Great Northern Telegraph Company will from May 1st, to all Stations in Japan (Nagasaki excepted), be 9s. 3d. per word of not exceeding ten letters. To Nagasaki the rate remains as before, 8s. 4d. per word.

Information was received on the 11th inst., by the Cuba Submarine Telegraph Company, Limited, of the repair of their 1870 Cable between Cienfuegos and Santiago-de-Cuba, thus restoring duplicate means of telegraphic communication with the West Indies.

Patents.

1079. "Telephonic apparatus."—W. Morgan Brown (communicated by A. Breguet, C. Roosevelt, and G. Lippmann). Complete. March 19.

1155. "Improvements in telegraphs, part of such improvements being also applicable to other electrical apparatus." R. and M. Theiler, and J. E. Wright, March 23.

1195. "Electric conductors."—H. E. Spalding March 26.

1196. "Electric conductors."—H. E. Spalding March 26.

1228. "Improvements in the constructing and working of electric telegraphs, and in apparatus connected therewith, partly applicable to other purposes."—H. Wilde. March 28.

1248. "Improvements applicable to insulators for telegraph purposes."—J. Oppenheimer. March 29.

ABSTRACTS OF PUBLISHED SPECIFICATION.

2131. "Electric pneumatic bells."—F. J. Money. Dated June 1, 1877. 2d. By this device a battery and electro-magnet are employed to ring a bell, the battery circuit being local with the bell, and closed by means of a pneumatic arrangement, whereby the ringer forces air along a pipe which inflates a bellows at the other end, and thereby closes the bell circuit. *(Not proceeded with.)*

2194. "Galvanic batteries."—S. W. M. de Sussex, and L. A. Brasseur, Brussels. Dated September 8th, 1877. 1s. 2d. This consists in a method of constructing galvanic batteries on a large scale which may be actuated

by fresh or salt water. A portable battery described is formed of a wooden trough partitioned off as in Muirhead's battery; but it has a special feature in a double bottom. The upper or false bottom is pierced with a row of holes, so that the fluid not only fills the separate cells, but a gutter running along between the two bottoms. The solutions of all the cells in this way intercommunicate. This gutter has also an opening to the exterior of the cell, fitted with a stopper, whereby the trough can be filled by simply immersing it in the solution, or emptied by tapping. In the same way provision is made for constructing floating batteries, permanently immersed in the sea, of sufficient size to light buoys and beacons by means of a Rhumkorff coil and vacuum tube, or otherwise. The plates of such a battery are formed by enclosing a zinc slab between two plates or slabs of graphite, the zinc and graphite being insulated from each other, but very close.

2213. "Galvanic batteries." A. DE WATTEVILLE and J. MAYER. Dated June 7th, 1877. 2d. This consists of a single fluid battery, in which the positive pole is formed of zinc in mass or fragments, immersed in mercury, on which the exciting fluid floats. The negative pole may be carbon; as depolarisers, chloride of silver, bichromate of potash, or oxide of iron may be employed. *(Not proceeded with).*

2240. "Telegraphic and electric apparatus." C. F. Varley. Dated June 8th, 1877. 2d. This relates to the construction of condensers. Metal plates, sometimes perforated, or gauze, is covered with di-electric, such as silk netting, collodion or perforated paper prepared and varnished, or thin gutta-percha or vulcanised india-rubber. The paper is prepared by steeping it in strong nitric or sulphuric acid, washing it and then drying. Cotton net, prepared with acid and varnish, may be used also. *(Not proceeded with.)*

2291. Opening and closing gas cocks by electricity." D. MCCONNELL SMYTH, New Hampshire, U.S. Dated June 12th, 1877. 2d. This is specially applicable to street lamps. Electro-magnetism is herein employed to set a weight in motion at the distant cock, and the force of the momentum which this weight acquires by its motion effects the opening and closing of the cock. *(Not proceeded with.)*

2314. "Electro-magnetic motors."—W. W. GARY, Washington, U.S. Dated June 14th, 1877. 6d. This describes a motor, in which the power is obtained from permanent magnets by means of a small battery, and consists in arranging a vibrating electro-magnet, the poles of which are reversed at each movement between two permanent magnets, set with their opposite poles facing each other. The permanent magnets are fixed with their opposite poles facing each other a short distance apart, and an electro-magnet, which is attached to the driving mechanism, is mounted so that it may vibrate freely to and fro between them. The helix of the electro-magnet is connected to an ordinary battery in circuit with an ordinary device for reversing the polarity of the electro-magnet, actuated by the moving parts of the motor, so as to reverse polarity at or near the end of each movement of the electro-magnet.

2390. "Electric traps."—S. FYNN and C. CROPLEY. Dated June 20th, 1877. 2d. This consists in a means of closing traps by electro-magnetism. *(Not proceeded with.)*

2430. "Apparatus for multiple telegraphy."—ELISHA GRAY, Chicago, U.S. Dated June 22nd, 1877. 6d. This consists in a union of Gray's electro-harmonic and telephonic apparatus (described in patents No. 2646 of 1874, 974 of 1875 and 1874 of 1876), ordinary Morse system of sending, so that electro-harmonic signals and ordinary Morse signals may be received at the same time. In working under this improved system, a resistance coil is applied to each transmitting key of the Morse apparatus, so that the resistance is cut out while the Morse key is closed, and the circuit is not broken when a Morse key is open, thus allowing the harmonic instruments to work regardless of the Morse instrument. When the Morse key is open, the line current is so enfeebled by the resistance inserted, that the Morse relay breaks the local circuit. The vibratory currents of the harmonic apparatus do not affect the Morse relay, and as the Morse keying does not break the circuit, it does not interfere with the harmonic sending. In working this improved system, it has been discovered that when the harmonic vibrations are thrown upon the line, the attractive force of the Morse magnet is weakened by 40 per cent. This creates a tendency in the Morse relay to respond to the harmonic or vibratory signals as well as the Morse signals, and to avoid this defect a compensating battery of a strength equal to 40 per cent. of the regular main battery is inserted in the circuit. This battery is added to the ordinary Morse signalling battery by the act of sending the harmonic signals. Instead of a resistance coil being thrown into the circuit by the opening of the Morse key a small battery may be thrown in for a similar purpose. This method is operated on the closed circuit system, and way messages may be sent by the terminal batteries.

2449. "Electric telegraph apparatus." — J. W. BROWN. Dated June 25, 1877. 2d. This consists of a relay for Morse signalling on submarine or difficult land circuits. A suspended coil, or electro-magnet is caused to move by the line current. It gives motion to a contact piece connected with one end of a local battery. The other end of the battery is connected to several contact pieces through coils of different resistances. A Brown and Allan relay (Patent 1757 of 1876) is placed in circuit with the local battery. When the line current reaches a certain strength, the contact piece connected with the positive end of the local battery moves against one or other of the contact pieces connected with the negative end of the battery, thus making a local circuit through a certain resistance. and actuating the Brown and Allan relay, which in turn actuates the recorder. Upon a decrease in the current, the positive contact piece is moved against another negative contact piece, throwing in a greater resistance, and causing the B. and A. relay to break the recording circuit. *(Not proceeded with.)*

2463. "Relays for electric telegraphs."—C. H. G. RISCH. Dated June 26, 1877. 6d. This describes a polarised relay for long land lines or cables, so constructed as to follow the varying positive and negative signal currents. For this purpose the tongue is made in the form of a circle, or segment of a circle, mounted at its centre, so that it can freely turn horizontally. This tongue is either a permanent magnet, or capable of being polarised by induction at its centre from a permanent or electro-magnet. The tongue is placed between two electro-magnets, so that its circumference is nearly in contact with the adjustible poles of the latter. From the tongue an arm projects between two adjustible contacts, which are free to slide or shift to right or left together, and for this purpose they are preferably mounted on an arm free to oscillate. When no current is passing through the electro-magnets, the induced magnetism of the tongue acting inductively on the cores of the electro-magnets, causes the tongue to maintain its zero position without the aid of springs, or other means of adjustment; but when a current from the line traverses the electro-magnets, the tongue is turned out of its zero position, and the projecting arm makes contact on one side with the yielding contact

point, which it pushes aside while still making contact with it. The other contact follows, so that on a revival of the current, the arm by a small movement makes contact with it.

2480. "Galvanising."—R. HEATHFIELD. Dated June 27, 1877. 6d. This consists in an arrangement for enabling sheet iron to enter the galvanising pot lengthwise instead of endwise.

2509. "Galvanising iron."—F. BRABY and A. C. MOORE. Dated June 29. 6d. This is to avoid the injurious and discolouring effect of the muriate ammonia flux ordinarily used in the bath to prevent oxidation of the zinc on the galvanised iron as it leaves the bath. A narrow space at the egress of the iron from the bath is kept clear of flux. This space is formed by two partitions in the form of rollers, which are kept revolving in opposite directions, so as to skim or keep the surface of the bath between clean.

TRAFFIC RECEIPTS.

Name of Co., with amount of capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £90,000.	Cuba Sub. Co. £16,000.	Direct Spanish Co. £13,000.	Direct U.S. Co. £65,000.	Eastern Co. £369,700.	Eastern Ex. Co. £199,750.	Gt. Northern Co. £125,000.	Indo-Euro. Co. £17,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £69,910.	West India Co. £88,320.
	£	£	£	£	£	£	£	£	£	£	£	£	£
March, 1878 ...	48,630	14,232	*3,500	880	11,580	38,201	23,112	18,156	... ...	10,054	3,425	12,300	6,229
March, 1877 ...	18,880	11,374	3,025	913	8,110	35,591	22,886	16,115	... ...	9,914	3,128	10,380	5,854
†Total Inc. 1878	53,090	1,104	1,751	... ...	... ...	8,342	55	2,688	... ...	726	... ...	... ...	2,681
†Total Dec., 1878	... ...	... ...	... ...	10	1,840	... ...	... ...	... ...	... ...	... ...	1,966	1,625	... ...

* Estimated. † Compared with same period 1877.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

AT the ordinary general meetings held on the 13th and 27th ults., a paper by Mr. J. Gavey was read, and a discussion ensued, on the subject of "Insulators for aërial telegraph lines."

In dealing with the principles which should guide the selection of an insulator, the author treated his subject under two heads, viz., the *material* of which the insulator is to be composed, and the *form* which should be given to it.

(1.) *The material* should offer an electrical resistance as nearly as possible infinite; it should be homogeneous and non-porous throughout; it should be capable of taking a high polish or smoothly glazed surface; it should not be subject to deterioration, either externally or internally, through atmospheric or other causes; it should be readily moulded into any desired form; it should have as slight an affinity for water as possible, and its tensile and compressive strength and toughness should be sufficient to enable it to withstand the maximum strains to which it is liable to be subjected, as also the ordinary rough usage.

While on the subject of porosity, Mr. Gavey mentioned that he had made a series of experiments with various samples of oolite, lias, alabaster, and sandstone, the conclusion he had arrived at being that only at temperatures far above ordinary atmospheric temperatures, is it possible to expel absorbed moisture from a porous substance.

The principal materials hitherto used for insulators are glass, porcelain, earthenware, ebonite and wood saturated with insulating compounds.

Glass, originally one of the first materials used, was rejected in this country, on account of its readily condensing films of moisture over its surface, and also because of its brittleness and its tendency to fracture under variations of temperature. It is now, however, used in America and Switzerland to a considerable extent. It possesses, in a high degree, many of the requisite qualities of a material for an insulator. Its electrical resistance is almost infinite. It is non-porous, homogeneous, highly polished on its surface, readily moulded into any given shape, and easily manufactured of a given quality, but unfortunately the objections already mentioned were found so strong as to lead to its entire rejection in England.

Porcelain has perhaps been more widely adopted than any other material, and, if properly selected, well manufactured, thoroughly burnt, so that a partial vitrification takes place throughout, it becomes homogeneous and non-porous, probably affording the best material hitherto used. If of really good quality it satisfies many of the conditions laid down, its principal defect being its brittleness. Of course much depends on the selection of the ingredients of which it is made and on the care devoted to its manufacture.

According to the description of clay used, and the different proportions in which this is mixed with the powdered flint and other materials employed, will the porcelain be hard or soft. The proportions used are generally trade secrets, each maker having his special formula for mixing. That manufactured in Prussia, is of a very fine description, extemely hard, and is much liked.

In this country a softer porcelain generally is used for insulators. It is probable that the harder German porcelain gives a higher specific resistance than English porcelain generally, but the latter can be selected so as

to give such a high result as to be practically infinite. There is no evidence to show that the softer qualities deteriorate more rapidly under atmospheric or electrical influences than the harder ones.

The final test for any material used for insulators, is, of course, the electrical one: for invisible fissures, porosity, or other imperfections, are thereby detected; but a careful examination of the fractured sections of an insulator will generally give some idea of its quality. If properly made up and sufficiently fired, the fractured surfaces will be more or less conchoidal, smooth, and homogeneous in appearance. Any departure from this evidently indicates imperfection.

The following are the principal causes of the low resistance of porcelain insulators which are rejected after being exposed to the ordinary tests.

1st. Flints not ground fine enough to make with the other constituents of the porcelain a smooth paste. The fractured section of the ware, when examined with a lens, is roughly comparable to a quarry of chalk with its intermixed flints.

2nd. Insufficient firing to fuse the flux.

3rd. Excessive firing, which makes the ware spongy.

It will be seen that these are merely defects in manufacture, preventible by the adoption of proper precaution; and as they are readily detected they do not militate against the use of the material itself.

Stoneware, which has been employed to a considerable extent in this country, is perhaps of a more variable character than porcelain, but if carefully selected, moulded under a considerable pressure, aud well burnt, it falls very little short of porcelain as a material for insulators.

Ebonite, which appeared a most promising material, and was at one period most extensively used, failed through its rapid surface deterioration under the influence of the atmosphere.

Wood, saturated with insulating substances, has been tried, but it is questionable whether a high-class insulator could with safety be turned out of this material. It is extremely difficult to deprive wood of its strong tendency for absorbing atmospheric moisture; in fact, it is a question whether it would be possible to entirely fill up its pores; and the freedom from malicious fracture, which its use would carry with it, would be dearly purchased at the cost of the lowered insulation which would certainly follow any failure in the attempt to render it impermeable.

(2.) *The Form.*—The theoretical conditions to be aimed at in designing the form of an insulator may be enumerated as follows:—

The maximum resistance should be obtained by increasing the length to be traversed by the current, whilst diminishing the section of the conducting film; by the retention of a dry surface on one portion of the insulator, if possible, under all circumstances and by the adoption of a form that will not aid or retain deposits of dust, soot, or other materials which act injuriously by retaining and increasing the thickness of the moisture films.

Taking the resistance through the substance of the material selected as approximately infinite, which it would be practically in any but a defective specimen, the conductivity of an insulator arises through the deposition of a film of moisture over its surface. Now the ordinary law, that the resistance of a conductor varies directly as its length and inversely as its section will evidently apply in this case as in others, and therefore in calculating the resistance of a given insulator, we have to consider the distance over its surface from the point where the wire is attached to the point where the insulator is affixed to the pole; and also the thickness of the film of moisture multiplied by the mean circumference of the insulator. Assuming, therefore, that under like atmospheric conditions the thickness of the film of moisture deposited on various forms of insulators of the same material will be constant, the resistance of each insulator will vary directly as its length and inversely as its mean circumference. This law in practice applies with accuracy only to simple cylinders, for in complex forms of insulators other disturbing causes are introduced.

In the early days of telegraphy, various substances were tried (among which was a simple goose-quill) and improvements made, by which the standard of insulation was gradually raised, until in 1856 Mr. Latimer Clark introduced on the lines of the Electric and International Telegraph Company the well-known porcelain invert, which may be called the parent of a whole generation of the modern form at present in use. It consisted of a so-called double-cup insulator, supported on a vertical pin, and containing a deep groove in the top to carry the conductor. These were largely used in England at the time they were first made, but they were subsequently replaced by Varley's well-known earthenware insulator, in which the two cups were altered in shape, prepared in separate pieces, and cemented together, so that a flaw or fracture in one would not destroy the insulating power of the whole.

The postal telegraph department of Great Britain has lately introduced a new insulator of the double-cup form, in which the length is considerably increased, and which is attached to the bolt by means of a female screw in the interior of the cup, fitting a corresponding thread at the upper extremity of the bolt. An india-rubber washer, placed between the lower end of the insulator thread, and a flange on the bolt, prevents fracture of the insulator by over-screwing.

In Prussia the porcelain invert already referred to was adopted early after its invention, and the present form in use in that country may be said to be but a modification of the original, the weak parts being strengthened so as to better resist the effects of ill-usage, and the sections lengthened to increase insulation. These insulators, or modifications of them, have been introduced in the German Confederation, Russia, Sweden, Denmark, Italy, and Spain. They are likewise used by the Indian Government Telegraph Department.

(*To be continued.*)

PHYSICAL SOCIETY.—March 30th, 1878.

Prof. W. G. Adams, President, in the chair.

The following candidates were elected members of the Society:—S. Bidwell, M.A., LL.B., W. Grant, E. Gurney, and J. H. Smith.

Mr. W. H. Preece described Byrne's Pneumatic Battery, and exhibited some of the results that may be obtained by its means. It is especially devised with a view to provide the medical profession with a portable battery, capable of producing a considerable amount of heat, as required for cauterizing. The negative plate consists of a very thin plate of platinum to which a lead backing is soldered, and this is covered with a sheet of thick copper also coated with lead, the whole being then covered with a non-conducting varnish, with the exception of the exposed platinum face. Two of these plates are arranged to face the zinc plate, as in Wollaston's form of cell, and the exciting liquid consists of 12 oz. bichromate of potash, one pint of sulphuric acid, and five pints of water. By using such a mixture, the sulphuric acid attacks the zinc, and the three atoms of very loosely combined oxygen exercise a depolarising effect, by absorbing the evolved hydrogen. A fine

tube dips into the exciting liquid, and is so arranged that it conducts a current of air, from a small pair of bellows, against the face of the negative plate; by this means any bubbles of hydrogen are, as it were, brushed off, and the current obtained from a given electro-motive force is materially augmented. Mr. Preece then referred to several old forms of battery in which such an agitating principle is introduced, notably those of Grenet, Chutaux, and Comacho, and he went on to describe a series of experiments he has made with a view to ascertain the cause of the great heating and illuminating effects that could be obtained with the apparatus exhibited. He showed that the effects were due to the mechanical agitation of the liquid on the face of the negative plate, but whether the great production of heat in the battery, and the great lowering of its internal resistance were chemical, thermal, or electrical effects, remains for further investigation. By means of a small battery of four cells, in which the plates were 4 inches by 2 inches, a length of 6 inches of platinum wire, No. 18 (0·05 inch), could be heated to bright redness, and much more powerful effects were obtained by a large battery of ten cells, made by Ladd. In this case, about 2 feet of a No. 14 (0·089 inch) wire were heated, and it was shown that when connected with an 18-inch inductorium, kindly lent by Mr. Spottiswoode, sparks of over 17 inches could be obtained, but this length was reduced to about 8 inches on stopping the current of air. A similar effect was also very marked when the poles were connected with two carbon points, the light given out when the air current was introduced being remarkably bright and steady.

Mr. PREECE then exhibited an ingenious method of showing the vibrations of a telephone plate to an audience, which has been devised by Mr. H. Edmunds. A vibrating plate is employed to break contact, as in Reiss' original telephone, and is introduced into the primary circuit of a small induction coil. The induced current is employed to illuminate a rapidly rotating Gassiot's tube, and, on making and breaking contact, by speaking into the resonator, an illuminated star is observed, the number of whose arms varies with the pitch of the note; with a very low note it may resolve itself into a single straight line.

Lord RAYLEIGH exhibited and explained an arrangement which he has employed with advantage in certain acoustical experiments in order to secure absolute uniformity in the rate of rotation of an axle. After referring to the mathematical principles involved in such a problem, he explained that the only hope of its solution lay in the employment of a vibratory movement, which by some suitable device must be converted into a motion of rotation. The axle whose motion it is required to maintain uniform is usually driven, at an approximately uniform rate, by means of a small horizontal water wheel or, in some cases, the electro-magnetic regulating apparatus, presently described, is sufficient by itself to supply the necessary power. At equal distances round the axle are arranged four soft iron armatures, which successively come in front of the poles of a horse-shoe electro-magnet, placed in the circuit of a four-cell Grove's battery. The current is rendered intermittent by the following arrangement:—Passing into the body of a tuning fork, vibrating about forty times per second, it leaves by a small platinum stud, which is touched at each vibration of the fork; the current then traverses a second small electro-magnet, between the prongs, and by this means the vibrations are maintained: passing to the magnet above referred to, the current then returns to the battery. The velocity of the axle is such that it performs about one complete revolution for every four vibrations of the fork, and the exact adjustment is effected as follows:—If the driving power be just sufficient to produce the desired speed, the armatures will be so attracted by the magnet as to be exactly opposite to it at the middle of its period of magnetisation, and so long as this position is maintained, the magnet will not (on the whole) affect it. But if a disturbance occur in the driving power, the armature will be displaced from its former position, and will be attracted by the magnet until the error is compensated. Besides the armatures, this axle also carries, concentric with it, a hollow metallic ring filled with water, and as this possesses a certain momentum in virtue of its rotation, it will act as a drag, tending to check the velocity in case it increases, and in the converse manner when a diminution occurs. A blackened disc, perforated with rings of holes of various numbers, also rotates with the axle, and by placing the eye behind the ring of four holes, and observing a prong of the fork, it is easy to ascertain whether the uniformity is maintained, since in that case the prong will appear to remain stationary.

THE INSTITUTION OF CIVIL ENGINEERS.

AT the meeting on Tuesday, the 26th of March, Mr. BATEMAN, President, in the Chair, the Paper read was on "Direct Acting or Non-Rotative Pumping Engines and Pumps," by Mr. Henry Davey, Assoc. Inst. C.E.

The author discussed some new forms of direct acting pumping engines and pumps, as a question of relative cost and efficiency, illustrating his arguments by practical examples. The direct acting engine had a wider sphere of application in mining operations than elsewhere, and experience had proved it to be the best type for deep mine and heavy pumping. Until lately, the Cornish had been the only direct acting expansive engine. It was a very economical machine under favourable circumstances, but its range of expansive working was limited. Compound rotative engines had been made to do a higher duty than Cornish engines. In the early days of pumping, Hornblower, Trevethick, Woolf, and Sims experimented with compound Cornish engines in Cornwall; but these attempts had failed because the engines were single acting, and the distribution of steam was such as to lead to great thermal loss from the cooling influence of the condenser. From these and other practical defects the engines fell into disuse. To work direct acting engines expansively, certain conditions were necessary. An inert mass must be provided, which, by its inertia at the beginning and momentum towards the end of the stroke, should compensate for the diminishing pressure of the expanding steam employed in overcoming the almost uniform resistance of the pump. In single cylinder engines this involved heavy initial strains, considerable piston speeds, and a large inert mass to render a high degree of expansion possible. These obstacles were removed in the direct double acting compound engine. It was shown that the cost of the engine and buildings was less for a compound than for a Cornish engine. The author advocated much heavier lifts than those commonly used. As examples, a 200 H.-P. compound engine employed underground in forcing against a column 1,100 feet in height, and a 600 H.-P. compound engine actuating two 20-in. plungers by spears against a column of 700 feet were referred to.

In the discussion which followed the reading of the paper, and which was concluded at the meeting on the 2nd of April, Dr. Pole referred to the experiments made on a Cornish engine, established some years ago near London, which proved that the results obtained from such a form of engine was exactly what theory indicated, and that this form of engine was especially suitable for

mines, and where the lift was considerable and the resistance to be overcome uniform. Mr Bramwell said that the value of the Cornish engine was exaggerated, and regarded it as unsuitable for waterworks, except for pumping water into tanks, as the force required to send the water through the mains was very variable, and he pointed out that in order to secure the engine against injury in the event of a sudden diminution of pressure various expedients had to be resorted to, such as pumping the water to a greater height than was required and letting it overflow, also throttling the pipes and other methods for artificially increasing the resistance. Consequently, though the work might be cheaply performed, the value of the economy was lost by the additional work imposed, and he considered a rotatory engine as the proper form to adopt. Mr. Latham differed entirely from these views, and reckoned the loss of water in pumping with a rotatory engine at not less than 25 per cent.; and whilst thinking that with the Cornish engine the loss was very slight, he considered the engine at the Croydon Waterworks, where the motion was regulated, was better. Mr. David Thomson said that with a rotatory engine, pumping up the London sewage, the amount delivered was in excess of the theoretical amount, as owing to the length of suction pipe the water continued passing through the valves at the end of the stroke. Mr. Stephenson agreed with Mr. Bramwell in considering a Cornish engine unsuitable for pumping owing to its irregularity, and related how, at a colliery with which he had been connected, the beam of a Boulton and Watt engine smashed some strong cross timber beams placed to regulate the motion of the engine when the water pressure was reduced. Mr. Davey, in his reply, affirmed his belief that direct acting engines were more economical for great lifts, and much simpler than rotatory engines, and that the loss from slip was less except when the rotatory engine was in perfect adjustment. This opinion was endorsed by Mr. Barlow, who remarked on the preference exhibited by the Americans for direct acting engines, as exemplified by the numbers exhibited at the Philadelphia Exhibition compared with those of the rotatory type.

On Tuesday, the 2nd of April, Mr. BARLOW, Vice-President, in the Chair, a Paper was read on "The Huelva Pier of the Rio Tinto Railway," by Mr. T. Gibson, Assoc. Inst. C.E.

The cupriferous iron pyrites mines of Rio Tinto in the south of Spain, about 50 miles from the Port of Huelva, which was situated on the River Odiel, had been worked by the Romans. Their out-put last year amounted to 750,000 tons. The traffic from the shore to the vessels was formerly carried on by barges and small craft; but with an increased trade a cheaper and more expeditious plan of shipping minerals was needed. The marshy bank of the river was scarcely two feet above high water, and there was a substratum of soft blue clay more than 80 feet in depth. A screw pile pier was considered best adapted to the locality. Having regard to the large amount of material to be shipped, and the advisability of being able to do this rapidly, it was decided to build the pier on a rising gradient, so that the train of waggons could be pushed up by a locomotive to the height requisite for shipping the ore by gravitation, in preference to making the pier level, and raising the waggons at the extremity to the requisite height by hydraulic or other power. The plan adopted was similar to that used by Mr. Harrison at the Tyne Docks for shipping minerals.

The pier had been so designed that the waggons were run direct to the spouts, and required no handling after leaving the locomotive engine. To allow of the ore being shipped at all states of the tide, the shipping places were 32 feet 6 inches above ordinary spring tides, and the pier was carried out into such a depth of water, that the loading of a light vessel could be begun at the top of the tide, and be continued when the tide was at its lowest. Another advantage of this plan was the possibility of providing a lower deck for the ordinary traffic of the port, especially for that which will be brought to it when the Seville and Huelva Railway was completed.

The total length of the pier and of the approach from the station yard was 2,444 feet. The screw pile portion was 1,900 feet long. This distance was made up of twenty-nine spans of 50 feet each, and thirty groups of cast-iron screw piles and columns, eight in each group, placed 15 feet apart from centre to centre. The pier-head, alongside which the ships were moored, was protected by the shipping deck wharf, which was constructed of memel timber work, and was independent of the cast-iron piling.

The depth at low water spring tides at this wharf was 15 feet. There were three floors at different levels throughout the length of the pier, and upon these were laid seven lines of rails. These floors were carried upon wrought-iron lattice girders 4 feet deep, and were supported by the screw piles and columns. The cast-iron hollow screw piles were 16 inches in diameter, and the lowest length of the pile shaft was fitted with screw blades 5 feet in diameter and having a pitch of 6 inches. The principal difficulty was the want of solidity of the foundation, which proved to be worse than was at first anticipated. It was therefore decided to provide additional bearing surface by the introduction of timber platforms, fastened to the piles by cast-iron discs, which clamped the respective piles below a collar cast specially on the pile shaft, so as to rest upon the disc. The platforms at the shore end were weighted to 300 tons, and those in the deep-water section to 500 tons. When the loaded platforms ceased to sink, a diver was sent down to fix the discs forming the connection between the piles and the platforms, and the load was then removed.

There were four sets of shipping spouts, two on each side of the pier-head, constructed to meet the varying levels of the water, and the different heights of vessels. Fifteen minutes sufficed to despatch a loaded vessel from the wharf, and to place another in its berth ready to be loaded.

In the discussion on the Paper, Mr. BRUCE said that the form of pier adopted though more costly than a level pier, was worth the difference in cost in consequence of the great convenience it afforded. As a wooden platform had been used, for the sake of economy, water pipes had been laid along the pier in case the wood in such a dry country should at any time catch fire, though protected by a covering of ballast. He predicted that when the new railway was opened, and general goods brought for shipment along the lower roadway, Huelva would soon outstrip Cadiz as a port. Mr. DIXON regretted that an iron platform had not been adopted. The expedient of sending out the screws detached from the piles had both reduced the cost of freight and diminished the liability to fracture. He said that apparatus worked by steam had been devised for turning the screw piles, but, that proving inapplicable under the special circumstances, manual labour was employed. The arrangement of the lines was so good that the ore could be shipped as fast as it could possibly be brought from the mines.

The Annual Dinner of this Institution was held at Willis's Rooms on Saturday evening, the 6th of April, Mr. BATEMAN, President, in the Chair. The gathering

was a large one, and after dinner the usual toasts were given; General Sir Richard Wilbraham responding for the Army, and Admiral Sir George Elliot for the Navy. Sir Charles Adderley responded to the toast of Her Majesty's Ministers; and the Houses of Parliament were very fitly represented by Lord Granville and Mr. Gladstone, and the Visitors by Prince Louis Napoleon; and Mr. Lowe responded to the toast of "The Learned Associations," proposed by the United States Minister. The dinner may be regarded as having been very successful, both as respects the visitors and the speeches. Though Civil Engineers do not need that their works and the benefits conferred by them should be brought into notice, it is well that the profession as a body, should come occasionally before the public, and furnish an opportunity for public recognition.

General Science Columns.

THAMES HIGH-LEVEL BRIDGE.

Various schemes have, from time to time, been brought forward for relieving the traffic over London-bridge, and for giving a more convenient means of communication between the two sides of the Thames below the bridge. The widening of London-bridge has been proposed, but this would afford little relief unless the approaches to the bridge could also be widened, which has not been contemplated, and would involve a great expense; and the intended plan of widening by adding footpaths on each side, supported on iron brackets, would mar the symmetry of the structure. The chief objection, however, to this scheme is that the two sides of the river, below London-bridge, would be as widely separated as at present. The steam ferry recently opened at Rotherhithe, has to some extent met the necessities of the case; but, besides the delays always incidental to ferries, an accident has, for a time, suspended its operation, and its liability to interruptions renders this method of communication unsatisfactory in such a locailty. Both high and low-level bridges have been proposed, but from various causes none of these schemes have obtained the sanction of Parliament. Last year, however, several of the East London vestries urged on the Metropolitan Board of Works the necessity of providing a bridge below London-bridge; and the matter having been referred to Sir Joseph Bazalgette, he has prepared a design which was approved at the last meeting of the Board; and the Corporation of London propose to join with the Metropolitan Board in an application to Parliament next Session, for power to carry out the scheme. The site selected is at Little Tower-hill, between the Tower and St. Catherine's Wharf, about half a mile below London-bridge. The width of the river at that point is 850 feet, and as accommodation must be provided for the passage of shipping, either a high-level bridge under which the vessels can pass, or a low-level bridge with an opening span would have to be adopted. The disadvantage of the first type of bridge consists in the long approaches necessary for rising to a high level; and of the latter in the delays occasioned to the traffic when the bridge has to be opened for shipping, and the great inconvenience to the shipping when the bridge is closed across the river. The latter objections are the greatest and the preference has been given to a high-level bridge. The design consists of steel trussed girders arched in form, with a single span of 850 feet, and leaving a clear headway of 65 feet above Trinity high water mark. The bridge would have a carriage way 36 feet wide, and two footways each 12 feet wide, giving a total width of 60 feet, which is six feet wider than London-bridge. The approach road on the Surrey side would have an inclination of 1 in 40, and on the Middlesex side from 1 in 50 to 1 in 60. The southern approach would commence at the improved Tooley Street thoroughfare, east of Queen Elizabeth's Grammar School, and in order to rise to the required level without too sharp a gradient, the road would make a turn and a half round a spiral curve of 300 feet diameter, at the back of the Anchor Brewery, and thence go on to the bridge at Hartley's Wharf. The northern approach would commence at King Street, and go over little Tower-hill. The cost of the bridge is estimated at £1,250,000, and the approaches and land at £850,000, making a total sum of £2,100,000. We wish every success to the scheme, which would both supply a much needed means of communication, and confer on London the distinction of possessing the largest arched bridge in the world.

THE NEW IRON-CLADS.

Four iron-clads have recently been purchased by the British Government which were built in this country for foreign Governments, consisting of one turret-ship, constructed to order for the Brazilian Government, and three broadside ships constructed for Turkey. The first, formerly named the *Independencia*, and since christened the *Neptune*, was first undertaken by Messrs. J. and W. Dudgeon, and subsequently completed by Messrs. Samuda Brothers, is an iron vessel of 8,960 tons, protected with 13 inch and 11 inch armour plates on the turrets, and plates of 12 inch, 10 inch, and 9 inch on its sides, having an armament of four 38 ton, and two 6½ ton Whitworth guns. Its dimensions are as follows: length between perpendiculars 300 feet, extreme breadth, 62 feet 3 inches, and having a draught of 24 feet 4 inches forward, and 25 feet 2 inches aft. The engines, which have been constructed by Messrs J. Penn and Sons, are horizontal trunk screw engines of 9,100 indicated horse-power, having two cylinders of 118 inches diameter, with a stroke of 4 feet 6 inches. The vessel attained an average speed of 14·65 knots per hour on the trial trip. The dimensions of the broadside vessels are as follows: The *Belleisle* is 245 feet between perpendiculars, 52 feet extreme width, with a displacement of 4,700 tons. It is protected with 12 inch and 8 inch armour plates, and it has a draught of 19 feet forward, and 19 feet 6 inches

aft, and carries an armament of four 25 ton guns. It has horizontal twin screw engines of 4,020 indicated horse-power, having four cylinders of 65 inches in diameter, and 2 feet 6 inches in stroke. This vessel exhibited a speed of 12·99 knots per hour on trial. The second broadside ship is the *Orion*, which is a sister vessel to the *Belleisle*, and similar in every respect, but has not yet been launched. Its engines are estimated at 3,900 horse-power, and its speed at 12 knots. Both these vessels have been built by Messrs. Samuda Brothers, and their engines have been manufactured by Messrs. Maudslay, Sons, and Field. The third broadside ship is the *Superb*, which has been constructed by the Thames Ironworks Company, and engined by Messrs. Maudslay, Sons, and Field. It is 332 feet 3 inches in length, with 59 feet breadth of beam, and has a displacement of 8,950 tons. Its draught is 24 feet forward, and 26 feet aft. The armour plates are 12 inches and 9 inches in thickness, and its armament twelve 18 ton, and two 6½ ton guns. It has horizontal screw engines, having two cylinders of 116 inches diameter, with 4 feet stroke, which exhibited an average speed of 13·78 knots per hour on trial. All these vessels are now being rapidly brought forward to completion, and will shortly be ready for service, but it is probable that some alteration may be made in their armaments before being commissioned. They form part of the acquirements made by Government out of the six millions recently voted for special military preparations.

"RECENT EXPERIMENTS ON FOG-SIGNALS." (By Dr. Tyndall, F.R.S., Professor of Natural Philosophy in the Royal Institution.) Abridged.

Our most intense lights, including the six-wick lamp, the Wighan gas-light, and the electric light, being intended to aid the mariner in heavy weather, may be regarded, in a certain sense, as fog-signals. But fog, when thick, is intractable to light. The sun cannot penetrate it, much less any terrestrial source of illumination. Hence the necessity of employing sound-signals in dense fogs. Bells, gongs, horns, guns, and syrens have been used for this purpose; but it is mainly, if not wholly, explosive signals that I have now to submit to the notice of the Society. The gun has been employed with useful effect at the North Stack, near Holyhead, on the Kish Bank, near Dublin, at Lundy Island, and at other points on our coasts. During the long, laborious, and I venture to think memorable series of observations conducted under the auspices of the Elder Brethren of the Trinity House at the South Foreland in 1872 and 1873, it was proved that a short 5½-inch howitzer, firing 3 lbs. of powder, yielded a louder report than a long 18-pounder gun firing the same charge. Here was a hint to be acted on by the Elder Brethren. The effectiveness of the sound depended on the shape of the gun, and as it could not be assumed that in the howitzer we had hit accidentally upon the best possible shape, arrangements were made with the War Office for the construction of a gun specially calculated to produce the loudest sound attainable from the combustion of 3 lbs of powder. To prevent the unnecessary landward waste of the sound, the gun was furnished with a parabolic muzzle, intended to project the sound over the sea, where it was most needed. The construction of this gun was based on a searching series of experiments executed at Woolwich with small models, provided with muzzles of various kinds. The gun was constructed on the principle of the revolver, its various chambers being loaded and brought rapidly in succession into the firing position. The performance of the gun proved the correctness of the principles on which its construction was based.

Another point of interest was decided by the earliest Woolwich experiments. It had been a widely spread opinion among artillerists, that a bronze gun emits a specially loud report. I doubted from the outset whether this would help us; for I could "hardly imagine any other quality of the metal than its strength coming into play in the projected experiments." In a letter dated 22nd April, 1874, I ventured to express myself thus:—"The report of a gun, as affecting an observer close at hand, is made up of two factors—the sound due to the shock of the air by the violently expanding gas, and the sound derived from the vibrations of the gun, which, to some extent, rings like a bell. This latter, I apprehend, will disappear at considerable distance." The result of subsequent trial, as reported by General Campbell, is, "that the sonorous qualities of bronze are greatly superior to those of cast-iron at short distances, but that the advantage lies with the baser metal at long ranges."

Coincident with these trials of guns at Woolwich, gun-cotton was thought of as a probable effective sound-producer. The explosive force of gunpowder is known to depend on the sudden conversion of a solid body into an intensely heated gas. Now the work which the artillerist requires the expanding gas to perform is the displacement of the projectile. Such, however, is not the work that we want our gunpowder to perform. We wish it to transmute its energy not into the mere mechanical translation of the shot, but into vibratory motion. We want *pulses* to be formed which shall propagate themselves to vast distances through the atmosphere, and this requires a certain choice and management of the explosive material.

The more rapid the shock imparted to the air, the greater is the fractional part of the energy of the shock converted into wave motion. And as different kinds of gunpowder vary considerably in their rapidity of combustion, it may be expected that they will also vary as producers of sound. This theoretic inference is completely verified by experiment.

Those who have witnessed the performance of the 80-ton gun at Woolwich must have been surprised at the mildness of its thunder. To avoid the strain resulting from quick combustion, the powder employed is

composed of lumps far larger than those of the pebble-powder above referred to. In the long tube of the gun these lumps of solid matter gradually resolve themselves into gas, which on issuing from the muzzle imparts a kind of push to the air, instead of the sharp shock necessary to form the condensation of an intensely sonorous wave.

On the 22nd of February, 1875, a number of small guns, cast specially for the purpose—some with plain, some with conical, and some with parabolic muzzles, firing 4 oz. of fine-grain powder, were pitted against 4 oz. of gun-cotton, detonated both in the open and in the focus of a parabolic reflector. The sound produced by the gun-cotton, reinforced by the reflector, was unanimously pronounced loudest of all. With equal unanimity, the gun-cotton detonated in free air was placed second in intensity. Though the same charge was used throughout, the guns differed considerably among themselves, but none of them came up to the gun-cotton, either with or without the reflector. A second series, observed from a different distance on the same day, confirmed to the letter the foregoing result.

(To be continued.)

Action of Ozone on Iodine.—M. J. Ogier finds that all the oxygen compounds of iodine, even to periodic acid, may be obtained by the action of the electric spark passed through a mixture of oxygen and iodine vapour.

Copper and Zinc in the Human Body.—Small quantities of copper and zinc have been found by MM. Raoult and Breton under ordinary circumstances in the organic matter of the human intestines, and it therefore follows that the mere detection of traces of these metals in the body, is no proof of poisoning by their compounds, unless the quantity found notably exceeds the normal amount under similar conditions.

Iron in the Sun.—At a recent meeting of the French Academy of Sciences, M. Cornu stated that he had been led by discussion upon his spectral observations, to conclude that the position and relative splendour of the dark rays of the solar spectrum, are explained by the action of an absorbant layer existing upon the sun; the chemical composition of the layer being analogous to that of volatilised aërolites.

If this be so, and the external layer of the sun contain, like aërolites, a considerable proportion of iron vapour, the total mass of iron would be very great, and would exercise an appreciable effect on terrestrial magnetic phenomena. To this it might be objected that iron raised to incandescence loses its magnetic inductive action, but although it is known to do so to a very great extent, it is not at all proved that heated iron loses all inductive power. Interpreted by this theory, the diurnal variations of the magnetic needle would be due to the direct magnetic action of the sun, as Sabine has already maintained. The presence of a considerable quantity of iron in the composition of the sun leads to the enquiry whether all the sidereal bodies do no possess it by virtue of a common origin. The earth itself supports such a view. It is well-known that the mean density of the globe is 5·5 times the density of water, that is to say, it is nearly double the mean density of the elements which form the outer crust. It is therefore reasonable to conclude that the inner layers of the earth are of a heavier material than rock, in short, that they are metallic masses. Again, on considering the directive force of the magnetic needle, we are led to conclude that in all probability the central mass of the earth is largely composed of metallic iron. The moon also exercises a feeble but unequivocal action on the magnetic needle, and this may be taken as proof that iron exists in that body. Finally, the profusion of aërolites in our planetary system tends to confirm Laplace's hypothesis of the common origin of the heavenly bodies, and to cause us to regard these small meteoric masses as the type of elementary cosmical matter.

The foregoing remarks are based on the presence of static magnetic masses at the surface of the sun. If, however, certain portions of the vapour masses in movement at the surface of the sun are magnetic, induction currents would be set up in the neighbouring conducting masses. When viewed tangentially the solar protuberances appear of a splendour in excess of that due to their position, and the spectrum of this brightness is identical with that of very rarified hydrogen, traversed by the electric spark. Mr. Cornu, therefore, asks whether these gaseous protuberances are not traversed by induction currents in the neighbourhood of rapidly moving magnetic or electrified regions.

City Notes.

Old Broad Street, April 13th, 1878.

It has been briefly mentioned in the Telegraphic Journal that Mr. Van Choate has published an advertisement in a contemporary. Mr. Van Choate, who signs himself "General Agent of the American Cable Company," has, it seems, been seized with the fear lest "innocent inventors" should lose their money "by investing in a scheme gotten up simply in the interests of promoters and contractors, and which would prove more disastrous than that of the Direct Cable," the scheme to which Mr. Van Choate refers to, being the proposed new Atlantic Cable—and one which we have mentioned several times—from France or England to America. Reading the rest of the advertisement, we find, however, that anxious as Mr. Van Choate is to protect the interests of "innocent investors" he is more—decidedly more—concerned to defend what he alleges are the rights of the American Cable Company. According to this confident authority, the American Cable Company, and the American Cable Company only, has the right of landing cables on the American Coast. Moreover, Mr. Van Choate avers that "no new Atlantic Cable will, in future, be allowed to land on the United States Coast." Nor will "any foreign message sent over any new cable landed at any other point be allowed to cross the boundary lines above-named without valid authority from Congress." Mr. Van Choate proceeds to assert

that "this question has never before been brought to its legal bearings." Behold, indeed, a Daniel come to judgment! Our Daniel, too, declines to allow that the President of the United States has any power in the matter. Congress alone can come to a decision; and Congress, Mr. Van Choate plainly intimates, would do nothing that would be likely to prejudice the interests of the American Cable Company. It was not until we had perused the last clause of the advertisement that we realised why the present moment had been selected for its publication. We admit it must be absurd for any one to think of promoting a scheme for a new Atlantic Cable from France or this country to America in face of the declaration, if a declaration were necessarily a fact, that "the American Cable Company has also at the present moment an additional bill before Congress, which will give to said Company (*sic*) very extended privileges, and on terms with which it would be utterly impossible for any other combination to compete, either in offering inducements to Congress, or in transmitting despatches for the public." And, *ergo*, "any agitation of any Atlantic Cable scheme in the European markets, except that of the American Cable Company of New York, would be absolute folly, if not something worse." But, Mr. Van Choate, do tell us what that something worse is—for, in spite of your modestly-worded advertisement, we do not hear that the Anglo-French scheme has collapsed.

We find from the report of the Eastern Extension Telegraph Company that the total earnings for the half-year were £134,753. The working expenses amounted to £67,210, including £21,586 for cost of repairs and maintenance of cables. Thus the balance of profit is £67,543, or, adding the balance brought forward from the previous half-year to it, £80,842. An *interim* dividend of 1¼ per cent., making with previous distributions 5 per cent. for one year, has been declared, and £30,905 is carried forward to reserve. In the report it is stated that Colonel Glover, the managing director of the Company, has gone to Melbourne, in order to facilitate the negotiations for duplicating the Australian cable, and a conference on the subject is to be held at Melbourne this month, at which all the colonies will be represented. It will be interesting to learn the result of the conference.

At the meeting of the Direct Spanish Telegraph Company the chairman very naturally expressed his regret that he was not able to report more favourably of the half-year's proceedings. Mr. Bannatyne said that the directors had been disappointed, owing to the fruit trade with Spain last autumn not being up to the usual average, the necessary consequences being that the receipts of the company had been less. It is a fact worthy of notice that while the company had an increased number of customers during one period, the messages sent have not been increased. In other words, as the chairman explained, "persons who sent messages by the company had only sent about two-thirds of their usual number of messages." We are glad to learn that the prospect of affairs for the shareholders is, however, brightening. The three past months show, it is stated, a much better condition of things. Another encouraging feature is the circumstance that the expenditure of the company shows a decrease every year; though, as we hinted in our last issue, we think that a further reduction might be made without impairing the efficiency of the service. A dividend of 10 per cent. on the preference shares was declared.

At a Meeting of the Directors of the West India and Panama Telegraph Company on Wednesday, April 10th, it was decided to place a thousand pounds to the reserve fund, and also to recommend to the shareholders, at the approaching meeting, that a dividend at the rate of 1 per cent. per annum, free of income tax, on the Ordinary Shares of the Company, be declared for the half-year ending December 31st, 1877, in addition to the dividend, at the rate of 6 per cent. per annum on the First and Second Preference Shares of the Company.

It may appear at the first blush as if the item of "salaries and wages" in the yearly working account of the Great Northern Telegraph Company of Copenhagen were somewhat excessive. In most cases the amount chargeable under this head might well be more—some companies under pay their officers—but £31,059, taking into consideration that a further sum of £8,604 is set down to "expenses of stations, offices, and agencies," even on an entire income of £224,000, is, perhaps, nearly sufficient. On the other hand, the directors receive little enough for their services—only £1,500, or scarcely more than £200 a year each, being paid to them. The debtors to the company owe £38,314; to the creditors of the company is due £40,700. We notice, with satisfaction, that the reserve fund has been increased by the sum of £44,444.

In his circular just issued, Mr. William Abbott, avoiding any mention of telegraph securities—about which there is certainly not much to be said just now—discourses at great length upon the position and prospect of the London Chatham and Dover Railway Company. We had hoped that after that meeting at Cannon Street Hotel, nothing more would have been urged respecting the abandoned idea of a fusion between the Chatham and South Eastern Companies. Mr. Abbott is clearly not of opinion that it is folly to flog a dead horse, for he repeats all that was said at the Cannon Street meeting as if he had discovered fresh facts, and tries, with all his might, as if no one had tried before, to disparage the position of the South Eastern Company, evidently forgetful of the little circumstance that he was once himself an ardent advocate of amalgamation. We will not, however, follow Mr. Abbott's example. It has already been pointed out in the Telegraphic Journal, that the fusion of the Chatham with the South Eastern Company was, for a time, supported by those who subsequently became violent opponents of the scheme, and the suggestion was made that reasons which were not on the surface had something to do with the sudden change of mind. But there is an end of that matter. With respect to Mr. Abbott's calculations as to the future of the Chatham Company, we cannot profess to share to the full his sanguine expectations. To read his circular, one might almost imagine that there was but one railway company in the world worth a straw, and that was the enterprise which a wag once called "the London, Cheat 'em and Do 'em." Nevertheless, we do not see any reason why the Company—which has the advantage of being carefully managed, and possesses admirable officials—should not make progress. In truth, we believe it will do so. It ought to. Its Continental service must continue to be more remunerative, its home service from April to October must also yield a large revenue, and as Mr. Abbott points out, there are sources of revenue which still remain to be developed. The mistake is to endeavour to persuade the public that by investing their money in Chatham and Dover shares, they are performing a duty they owe to their families, compared with which, other obligations are trifling.

The Directors of the Globe Telegraph and Trust Company (Limited) have resolved that the *interim* dividends for the quarter ending the 18th instant be 3s. per share on the Preference Shares, and 2s. per share on the Ordinary Shares, both free of income tax.

The Submarine Cables Trust give notice that the coupons due on the 15th inst. will be paid on and after that date by Messrs. Glyn, Mills, and Co., 67, Lombard-street.

THE TELEGRAPHIC JOURNAL.
Vol. VI.—No. 126.

WILLIAM ORTON.

The Hon. William Orton, the President of the Western Union Telegraph Company of North America, died on the 23rd inst. He was a remarkable man. Born in the backwoods, bred in a log hut, educated under the guidance of his stern parents, by his own industry, observation, and self-help, he became a type of the backbone and strength of the United States. Self-reliant, keenly observant, terribly energetic, thoroughly business-like, he speedily worked himself into the front rank, and before he was 40 he became President of the Western Union. For years he ruled that Company with a rod of iron. "L'Etat c'est moi" was true of this Association. He was an autocrat, but a very just one. Though no telegraphist, he made himself perfect master of the details of every branch of the business. There was nothing that escaped his notice. Everyone that served under William Orton felt that he was serving under a master. His power was felt everywhere. The humblest operator in the most distant State felt that he was acting under the eye of his chief. He was a better electrician than the electricians, and he personally undertook the repair of a cable rather than send to England for a skilled engineer. He would spend a whole day in some distant office watching the working of the wires and the behaviour of the apparatus. He would make his own contracts for the purchase of material. Indeed, he probably maintained self-action to too great a state. It is impossible to administer a large concern without a proper distribution of work. William Orton tried to do too much himself. His industry was untiring, and there is no doubt that "work" has killed him. All his friends for some time had urged rest. He had just secured three months' leave of absence but the end came suddenly, and at the ripe age of 52 he suddenly passed away.

Unfortunately, in the United States, jobbery is rampant. It is the exception to find a man in power untainted and unstained. William Orton was the exception. No one could accuse him of being unjust or of being an extortioner. His honor was unstained.

He was a man of an excitable temperament, and he had been for a long time very much worried by the anxieties of a determined competition and by the wild financial operations of an unscrupulous speculating ring. One competition was stayed only to beget another, and nothing could restrain the Wall Street gang. The most serene mind could scarcely withstand the effects of such disturbing influences, a sensitive mind like his would necessarily suffer severely.

The progress of the Western Union Company under his control has been very marked. When he first assumed the presidency it possessed 37,380 miles of line, 75,686 miles of wire, 2,250 stations. It can now boast of 76,955 miles of line, 194,323 miles of wire and 7,500 stations. Its gross revenue was 6,500,000 dollars, and now it is 10,000,000. The capital and debt which was 46,000,000 dollars, is now 40,000,000 dollars. A reduction! The number of messages transmitted by it was 6,404,595, the number is now 21,158,941.

He frequently visited Europe and his face is well known in London. Few who ever knew him will forget him, and especially those who have been admitted into his confidence and his home, who have admired the sterling realities of the man, who have seen the affectionate regard of a husband and a parent, and who have watched the gentle influence of the Christian override the powerful influence of the stern man of business. He will be sincerely regretted by many friends in England.

VARLEY'S ELECTROSTATIC MULTIPLIER.

This apparatus consists of a vulcanite disc mounted upon an axis carried upon insulating standards, and capable of being rapidly rotated. On the face of the disc are fixed strips of tinfoil, radially and at distances apart. In front of the disc, and diametrically opposite the one to the other, are two collecting combs by which the electricity passes from the face of the disc to the conductors of the machine. As the disc revolves, the strips of tinfoil pass in succession in proximity to the collecting combs. In close proximity to the disc, but on the other side of it, are two pieces of wood, mounted on insulating standards, and serving as the inductors; they are about the same width, or somewhat wider than the collecting combs, and are of curved form, each inductor covering about a quadrant of the operative part of the disc, or that which passes near the points of the collecting combs, and upon which part on one side of the disc are the strips of tinfoil. The inductors are so fixed upon their insulating supports that the leading end or commencement of the inductor is immediately opposite to the collecting comb, but on the other side of the disc.

For the purpose of charging the inductors there are other combs similar to the collecting combs, and similarly placed, but removed from them by an angular distance of ninety degrees, so that they are opposite to the ends of the inductors, but on the other side of the disc. These combs are placed in

metallic connection with the inductors, each to each. To render the machine self-charging, the last mentioned combs also carry springs or wire brushes, which make metallic contact with studs upon the face of the disc, and in metallic contact with the tinfoil strips upon it, each to each. As soon as the machine is at work, these springs or brushes can be lifted out of contact by means of silken threads, or other convenient attachments.

FIG. 1

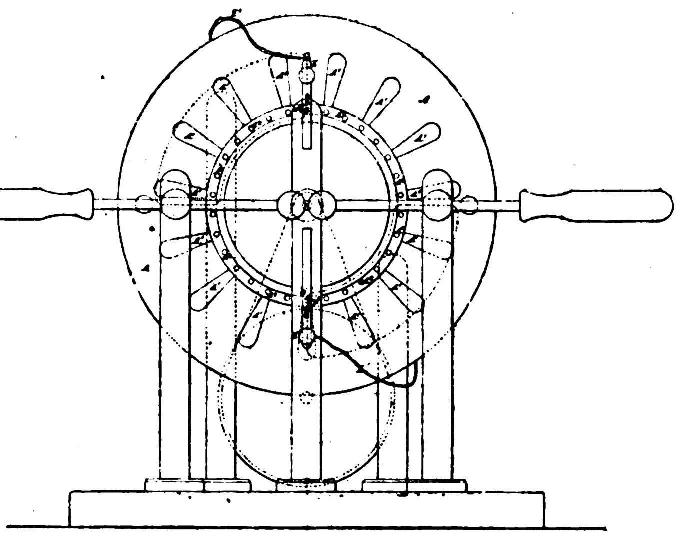


FIG. 2

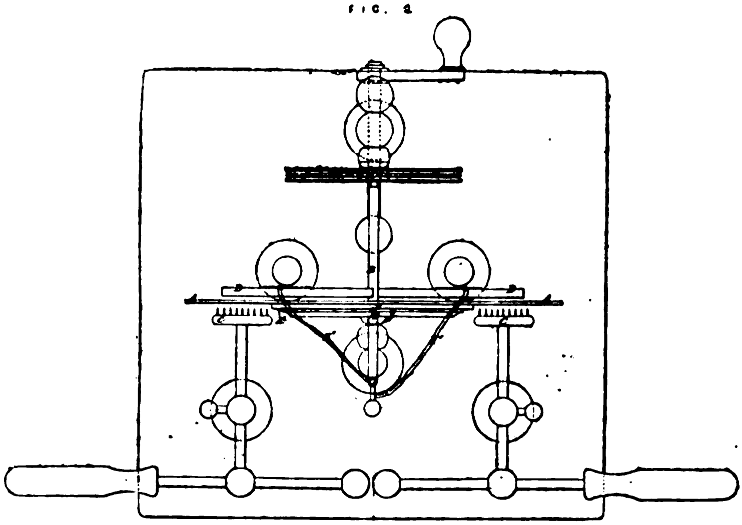


Fig. 1 is a front elevation, and fig. 2 a plan of the electrostatic multiplier. A is the vulcanite disc on an axis B carried by insulating standards. The axis has upon it a pulley which receives a driving cord from a wheel which is rotated by hand; A¹, A¹, are tinfoil strips fixed upon the face of the disc, and A², A², are studs in metallic connection with the strips A¹; C, C are metallic collecting combs, and D, D, are the inductors; both are carried upon insulating standards. E, E, are the combs for charging the inductors; they also are insulated, and they are connected by the covered wires E¹, E¹, with the inductors. E², E², are the springs or wire brushes for making contact with the studs A². The contact is made when a finger key (not shown) is depressed. The key acts through silken cords, which draw the brushes or springs forward; when the key is liberated they move back out of contact.

Mr. Varley proposes to employ his electrostatic multiplier in connection with the electric light, so as to render the latter constant. For this purpose, he places its conductors near the carbon holders, so that a stream of sparks may pass to them constantly so long as the light is being maintained. The high tension electricity, which in this manner is caused to pass between the carbon points, effectually maintains the magneto-electric discharge.

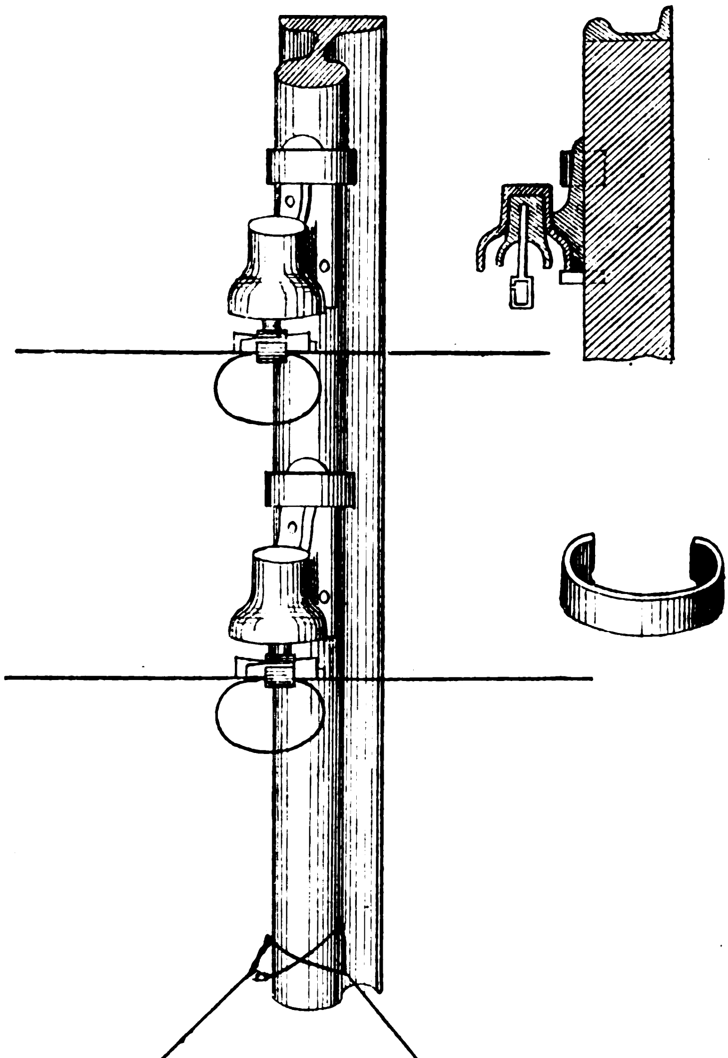
TELEGRAPH CONSTRUCTION IN THE BRAZILS.

By R. G. B. DAVIDS, Telegraph Engineer, Paulista Railway, Associate of the Society of Telegraph Engineers.

IN 1876 I was sent for from the Southern division of the English Postal Telegraph Service to take charge of the telegraph system of the Paulista Railway, Sao Paulo, Brazils. I left England under the impression that Siemens' iron poles were in use on the line, but great was my disappointment when, instead of seeing nice straight lines of iron poles, I found the most miserable erections I had ever seen. The poles were of wood, and of all shapes and sizes, set at various angles in the ground, and so crooked that they might fairly be compared to a cork-screw, whilst the wire, instead of being well stretched, hung in festoons of various dips, and in many places touching the ground.

I at once commenced making notes of pole roofs, stays, earth wires, &c., &c., but found after all that these miserable looking lines were the best that could be made under the circumstances.

Owing to the wood of the country rotting so quickly (in the usual place just below the ground line) it was a useless expense to fit up a pole as in England, for every three years, at the outside, the entire line had to be renewed; in one case the greater portion of the poles on a line of sixty kilometres had to be replaced after having been erected only one year.



This set me devising all sorts of means for the improvement of the line, amongst others, the

splicing of the poles at the foot with sound timber, the bolting of the poles to pieces of rails, &c., but I gave all these ideas up, as the expense would have been greater than the advantage gained, as I found that the poles in a short time tended to decay, generally over the whole length of the line.

As each pole cost three milreis (six shillings) and had to be renewed so often, I came to the conclusion that it would be far cheaper to send home for Siemens' iron poles, and renew the whole line at once, but this the Company did not feel inclined to agree to, owing to the larger prime cost of iron over wooden poles.

I should state that our line of railway consists almost entirely of curves, not curves such as are made on an English railway, but very much sharper, many of only nine hundred feet radius; the opinion of Brazilian engineers being that it is cheaper to make enormous deviations, and run miles away from the direct line, than to make cuttings and embankments. The greater portion of the line also runs through forests, with only a few metres clearance on either side of the track; for this reason, in order to keep the wires clear of the branches of trees and the tropical underwood, as many as from twenty-seven to thirty-two poles per mile have to be employed in some sections. Thus it will be seen that the question of the cost of maintenance of the poles required serious consideration.

The rails employed on the line are of the Vignoles type, twenty-one and twenty-four feet in length; of these there were lying in various localities hundreds, worn out and of no further value, even as old iron, owing to the great cost of transport to England.

Here I fancied there was what I required, but the question was at how little an expense and in what way were these to be employed?

Without a base plate, I at first thought that a rail would not support itself in the ground, especially on the sharp curves and soft banks, but I found upon experiment that this idea was unfounded, as a rail punned into a hole only three feet six inches deep, when blocks and tackle were attached to its top and pulled, bent to an angle of about sixty degrees and then cracked across, just below the ground line, without coming out of the ground.

The insulators employed on the line are Messrs. Siemens' iron hooded inverts, through the hooks of which on five poles the wire passes freely, being stretched and wedged at the sixth. These insulators I proposed bolting on to the rails, but to Mr. W. J. Hammond, the Locomotive Superintendent and General Manager of the line, I am indebted for the idea of the very simple, cheap, and admirable arrangement by which they are now fastened, and which I will endeavour to describe.

The rails are sent into the workshops, where they have two ¾ in. holes drilled about 1¼ in. deep, on the top face, the first being 12 inches from the top of the rail, and the second 16 inches from the first. Another hole, 1 inch in diameter, is at the same time drilled through the side of the rail, 18 in. below the second hole: this is for the purpose of fastening the stay wire, and is drilled 18 inches below in order that room may be left for the fixing of a third insulator, should such at any time be necessary.

Into the holes on the face of the rail are driven pegs, cut from ¾ in. bar iron, these pegs are allowed to project about ½ in. Upon them the insulators are set, and are fixed in position by means of an iron hand formed to clip the sides of the rail and driven over the plate of the insulator. I give a rough sketch of a rail with the insulators attached, which will perhaps make my description more clear.

The pegs and insulators are fixed on the line before the rail is erected, the bottom band being slipped on before the top peg is driven in, otherwise it would not pass it.

The rails are put six feet into the ground, and well punned, being lifted into their position by means of shear legs and blocks.

The holes are made by two tools, called respectively the "cavadeira" and the "enchada." The cavadeira is exactly similar to a very large flat carpenter's chisel, 8 in. long by 3½ in. across, fixed to a long handle; it is employed to break the earth. The enchada, a tool very similar to a Spanish spoon, is employed for clearing out the earth broken by the cavadeira. Marshall's earth borers would be far preferable to these tools, and I intend giving them a trial. When they arrive I expect to do the work of making the holes twice as fast as at present.

The stretching poles are stayed on either side, in the line of the wires, to prevent their being pulled over, in case both wires are broken at once by the falling of trees, &c.

When stretching the wires, the stay which supports the strain is only temporarily punned. When the wires are pulled up at the next straining pole the stay at the last is left very slack, the stay-block has, therefore, to be sunk deeper.

For stay wires I employ strand signal wire, and for stay blocks, old fire bars rejected from the engines, short pieces of rail, or, in fact, any old scrap iron.

The rails, when erected, are tarred all over, and as coal tar in this country dries like black varnish, it gives them a very good appearance.

As we are now passing through the rainy season they are having a rather severe trial, but I am happy to say there is not the least appearance of any one rail having sunk, or gone over, in the slightest degree.

The railway company, with which this line is in connection, being about to employ their old rails in a similar manner, I am induced to send this short description in the hope that it may prove of value to others who may be placed in a similar position to that in which I found myself.

MILLIWEBER, OR MICROWEBER?

By M. ROTHEN, Assistant Director of Swiss Telegraphs.

THE number of the *Journal Télégraphique* of 25th February, reproduced a proposal recently made by Mr. Preece before the Society of Telegraph Engineers of London for the adoption, for purposes of practical telegraphy, of the milliweber as the unit of electric current. In support of this proposal, Mr. Preece observed that the introduction of the milliweber would enable us to express by very simple figures the currents habitually employed on telegraph lines.

In my opinion this would be the only advantage of the proposed unit, an advantage of too small importance to compensate the serious inconveniences which its adoption would present from other points of view. With the *volt*, the *weber*, the *ohm*, and the *farad*, we possess a complete system of absolute electrical units, based on the centimetre-gramme-second. We are, furthermore, accustomed to regard as derived units the multiples which represent a million of the fundamental units, and the submultiples which represent the one-millionth part of such units; and we designate these derived units by the special denominations formed by prefixing "mega-" or "micro-" to the name of the fundamental unit. Either the fundamental unit, or one or other of its derivatives is used, according to which is best adapted to the electrical magnitudes dealt with in telegraphy. Thus the *volt* is almost exclusively used to express differences of potential, the *megavolt* being so large and the *microvolt* so small that it is very rarely these derived units can be made to represent differences of potential in simple figures. The *megohm*, on the contrary, is almost as often employed as the *ohm*, all resistances of dielectrics being much more simple in *megohms* than in *ohms*, while the *microhm* has only a theoretical value. The reverse occurs with the *farad*, where the fundamental unit is so large a quantity that the *microfarad* is the only one of its derivatives which corresponds to the quantities used in telegraphy. The whole capacity of a transatlantic cable, for instance, does not exceed 800 *microfarads*, or 0·0008 *farad*.

Nothing is more rational and logical than to choose as multiple and submultiple of the *weber*, the *megaweber* and the *microweber*. Why abandon here the system followed with derivatives of the other units, and upset the harmony which exists in the conception of absolute units? To simplify figures, says Mr. Preece; but is this advantage of such value that we should sacrifice to it uniformity in the constitution of derived units! I think not. Let us say, for example, 14 milliwebers instead of 14,000 microwebers: neither the idea nor the comprehension of the magnitude is clearer. The ohm furnishes us with a striking example. Such expressions as 1,000, 8,000, 15,000, 50,000 ohms are perfectly familiar to us, because they present themselves daily, so to speak, when we are dealing with resistances of telegraph lines or of rheostats. True, it must be admitted that the ohm is a rather small unit for our ordinary resistances, and that, for simplicity of expression, it would be preferable if it had a tenfold or hundredfold value, but it is unhesitatingly employed nevertheless.

The microweber is also, I do not deny, a rather small unit, and most frequently one is obliged to express magnitudes in thousands of microwebers. But this slight inconvenience, which we have just shown attaches to the ohm, does not appear to us a sufficient reason for the substitution of that exceptional derivative, the milliweber. Furthermore, there are numerous instances in which the microweber offers a standard value more appropriate than the milliweber. Such are, for example the cases of the currents of some derived circuits, of those which flow in telephonic circuits, through substances of low conductivity or delicate galvanometers such as the mirror galvanometer of Sir W. Thomson. In several of these cases, which are not purely theoretical but occur in practical telegraphy, the values should even be expressed in fractions of the microweber.

It would then, it appears, be inconsistent to choose, as proposed by Mr. Preece, the milliweber in place of the microweber, and I think, with Mr. Latimer Clark, that electricians will hardly decide upon the adoption of this new submultiple.

Finding myself in disagreement with Mr. Preece on this point I the more willingly agree with his other wish that the telegraphic world should make more frequent use of the weber than has hitherto been the case. It is, in fact, very desirable that the strength of currents should be always expressed in webers. This is the only means of obtaining precise expressions. As it is we do not even know the strength of current used by neighbouring adminstrations because a common unit is wanting, or rather because this common unit is not made use of.

Mr. Preece informs us that the mean current used in England on Morse circuits is 5,000 microwebers. This led me to determine the average of the currents used in Switzerland. To regulate the strength on Morse circuits, the administration makes use of a simple method, but one not presenting any very great exactitude. The strength of the current is indicated by the deviation of the needle of a special detector, the helix of which has 32 turns; and deflections of 30° and 36° are allowed as the minimum and maximum of current strength. This limit is large; perhaps, as we shall see, too large for good working.

Although all the detectors (boussoles) are constructed according to the same type, it will not appear astonishing that the indications for the same current vary sensibly for different detectors, and even, with the same detector they vary accordingly as the deviation is to the right or to the left. It may be said that there are no two detectors which under the same conditions give identically the same deviation; in certain cases the difference may be as much as 20 per cent., so that their indications cannot be trusted for equalising currents. To obtain, therefore, means which should be to some extent comparable, I was obliged to determine the value of the deviations of a large number of the detectors, by calculating for each of them, and in both positions of the needle, right and left, the necessary strengths in microwebers to express the maximum and minimum of the deviations allowed. I have thus obtained results which represent sufficiently exactly the two limits of the effective currents on Swiss telegraph lines.

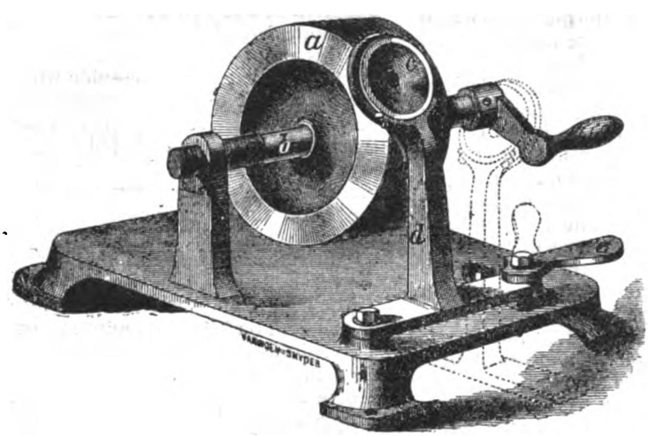
The electric currents circulating in Switzerland on telegraph lines with Morse receivers, must have a minimum strength of 8,900 and a maximum of 13,500 microwebers.

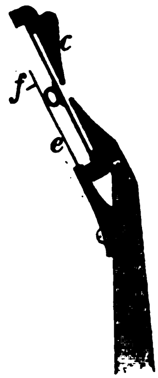
It is seen from these figures not only that the currents used in Switzerland are sensibly stronger than those in England (being double and even triple), but that the variation allowed is very wide.

It would undoubtedly be very useful and instructive to know similarly for other administrations the mean strengths of the currents employed, and that not only for Morse circuits but also for the other telegraphic systems in use.—*Journal Télégraphique.*

EDISON'S PHONOGRAPH.

FIGS. 1 and 2, for which we are indebted to the *Journal of the Franklin Institute*, Philadelphia, show the phonograph as at present constructed. Fig. 1 gives a general view of the instrument. Fig. 2 shows the diaphragm and stylus. The former is formed of a ferrotype plate, such as is employed in the ordinary telephone. The stylus is fixed to the end of a piece of watch spring, which presess against a small piece of india-rubber tubing fixed to the centre of the diaphragm. The piece of rubber acts as a cushion, and greatly improves the action of the apparatus, as it is found that if the stylus is attached directly to the diaphragm the action is not satisfactory. The diaphragm answers both for recording the impressions on the foil (lead) on the drum, and for reproducing the sounds, when the handle is turned. The diaphragm is mounted in a metal frame, attached to a moveable lever, which enables the point of the stylus to be withdrawn from the surface of the foil when the drum is to be screwed back to its starting position, after the impressions have been recorded. The dotted lines in fig. 1 show the position taken up by the frame and lever when the latter is turned back.





IT is announced from Berlin that England wishes to put off the Telegraph Congress till the 1st of June, 1879, in order to have ample time for testing the pecuniary results of the word tariff now existing between England and Germany, before discussing its extension to other countries and quarters of the globe.

THE SOCIETY OF ARTS.

TECHNOLOGICAL EXAMINATIONS.

THE Council have determined to add Telegraphy to the list of subjects in the Society's Technological Examinations.

The first examination will be held during the present month.

The syllabus for the use of candidates has been prepared as follows :—

TELEGRAPHY.

Examiner—William Henry Preece, Esq., C.E.

Part I.—General Science.

1. THE ELEMENTARY CERTIFICATE.—For this Certificate the candidate will be required to have passed in the elementary stage of

Subject 4. Pure Mathematics.
„ 9. Electricity and Magnetism.

2. THE ADVANCED CERTIFICATE.—For this Certificate the candidate will be required to have passed in the advanced stage of the above, and in the elementary stage of

Subject 10. Inorganic Chemistry.
„ 8. Acoustics, Light, and Heat.

3. HONOURS.—For Honours, the candidate must have passed in the advanced stage in the above subjects, and in either of the following subjects :—

Subject 6. Theoretical Mechanics.
„ 7. Applied Mechanics.

Part II.—Technology.

1. The construction, character, and difference of the various batteries employed in telegraphy.
2. The measurement of electrical quantities, and the character of different instruments of precision used in measuring and testing.
3. The character and quality of the different timbers and poles used in the construction of lines of telegraph.
4. Their decay and modes of preservation.
5. The manufacture, difference, and character of iron and copper wire.
6. The manufacture, character, and value of the different insulating materials used in protecting wire for submarine and subterranean purposes.
7. The principles, construction, and action of the different forms of apparatus in use in England in conducting the art of telegraphy.

8. The various natural disturbances that occur during different seasons of the year in impeding or destroying telegraphic communication, and the methods of protection adopted.
9. The causes that retard the rate of working on long land or submarine lines.
10. The various systems in use to increase the capacity of wires for the conveyance of messages.
11. The construction of aerial lines of telegraphs.
12. The principles and practice of jointing.
13. The construction of submarine cables; their laying and repair.
14. The various modes of joining up circuits.
15. The mechanical testing of the various materials used in telegraphy.
16. Faults; their nature, prevention, and localisation.
17. The applications of electricity to railway working.

Reviews.

Journals of the Society of Telegraph Engineers. Nos. XIX and XX. Vol. VI. E. and F. N. Spon, London and New York.

THESE two numbers decidedly show that the reputation of the journal is not likely to suffer; they give full accounts of the proceedings of the Society from April 25th to December 12th, 1877. No. XIX contains papers with discussions on "Batteries," by Martin F. Roberts, F.C.S.; "Double Current Translation," by Gustav Risch; "Description of a New Form of Electric Light (the Jablochkoff)," by W. Langdon, the late acting secretary of the society. Under the head of "Original Communications" we find "Abstracts and Information regarding Soundings taken with Sir William Thomson's Apparatus on the West Coast of South America," by H. Benest; "Description of Combined Key and Switch," by Andrew Jamieson; "Arrangement of Connections necessary for Employment with Sir William Thomson's Recorder or Speaking Galvanometer;" "Unifilar Suspension," by W. E. Ayrton and John Perry; "The Principles to be observed in the Erection of Wires over Long Spans," with tables, by R. S. Brough; "Improved Make and Break Arrangements for Sir William Thomson's Recorder Mill," by James Graves; "The General Theory of Duplex Telegraphy," by Louis Schwendler; "A Case of Lightning; with an Evolution of the Potential and Gravity of the Discharge in Absolute Measure," by R. S. Brough.

In No. XX we have papers and discussions on "Researches in Electric Telephony," by Professor A. Graham Bell; "Selenium, its Electrical qualities, and the Effect of Light thereon," by Willoughby Smith; "The Measurement of Currents," by W. H. Preece; "Earth Currents on Land Lines," and "Sonorous Properties of Electrostatic Induction," by A. J. S. Adams. We next find obituary notices of Major-General D. G. Robinson and of Ruhmkorff. Under the head of "Original Communications and Extracts," we have "Researches on Selenium," by Dr. Engen Obach; "A New and Practical Application of the Telephone," by Elisha Gray; "Earth Currents," by S. M. Barker; "Employment of old Railway Metals for Telegraph Poles," by R. G. B. Davids; "A New Wire Finder," by John Gott; "The General Theory of Duplex Telegraphy," by Louis Schwendler; "The Kaffir War and the Telegraph." An interesting letter from W. F. Channing on the Telephone completes the volume.

Notes.

WE understand that the Society of Telegraph Engineers is about to publish a complete catalogue of the electrical literature collected by the late Sir Francis Ronalds, F.R.S. The entries will be over 12,000 in number, and will include a record of the electrical papers contributed to the proceedings and transactions of the English and Foreign Scientific and Literary Societies. This catalogue, which has been edited by Mr. Alfred J. Frost, the acting-librarian of the society, is the result of many years of careful and patient labour, and, besides being a record of every publication relating to electricity and its application, will also serve as the catalogue of the valuable library formed by Sir Francis Ronalds, now in the possession of the society. We have seen a proof sheet of this catalogue, and we consider from the manner in which it is being produced that it reflects great credit upon the society, and especially upon its editor, and it cannot fail when published, to be a most valuable bibliography of the subject to which it refers.

TELEPHONIANA.—Since the time of Galvani the nervous fibre has been regarded as the most exquisitely sensitive galvanoscope. But the experiments of M. D'Arsonval prove that even an illmade telephone is at least a hundred times more sensitive than the nerve to feeble variations of the current. M. D'Arsonval prepared a frog's leg after the manner of Galvani, and excited the sciatic nerve by the secondary coil of a Siemens and Halske induction *appareil à chariot*, commonly used in physiological researches. After withdrawing the secondary bobbin from the primary until the nerve was insensible to the current, the telephone was substituted for the nerve, and forcible sounds were at once heard. In the silence of night M. D'Arsonval was able to hear the telephone when the secondary bobbin was withdrawn to fifteen times the distance at which the nerve ceased to be affected. Assuming that the intensity of induction decreases by the law of inverse squares, the currents indicated by the telephone were, therefore, at least 200 times weaker than those to which the nerve responded. M. D'Arsonval points out that these feeble induction currents are useful to adjust the telephone by. The telephone is likely to become useful in detecting nervous and muscular currents in

preference to the galvanometer and the Du Bois Raymond Coil, because the latter apparatus by the inertia of the needle is unfitted to indicate rapidly varying currents.

As another instance of the delicacy of the telephone Professor George Forbes of the Andersonian University, Glasgow, finds that when the hot point of a copper wire is drawn along the rasp of a file, the intermittent thermo-electric currents generated causes the telephone to emit a note.

It is reported that Professor Righi of Bologna has exhibited before the Academy of Sciences, Bologna, a telephone which speaks in loud tones.

The telephone has been adapted on the coast cable system, employed to facilitate the Norwegian herring fishery.

Professor Luvini, of the Military Academy, Turin, finds that the telephone sounds are increased by inserting two electro-magnets, wound with a great many turns of thick wire in circuit, one close to each telephone. A greater number of electro-magnets in circuit does not increase the effect.

Telephonic Bombast.—"The diaphragm of the telephone, the thin iron plate, is as sensitive as the living tympanum to all the delicate refinements of sound. Nor does it depend upon the thinness of the metallic sheet, for a piece of thick boiler-plate will take up and transmit the motions of the air-particles in all the grades of their subtilty. And not only will it do the same thing as the tympanum, but it will do vastly more: the gross dead metal proves, in fact, to be a hundred times more alive than the living mechanism of speech and audition. This is no exaggeration. In quickness, in accuracy, and even in grasp, there is perfection of sensitive capacity in the metal, with which the organic instrument cannot compare. We speak of the proverbial "quickness of thought" but the telephone thinks quicker than the nervous mechanism. Let a word be pronounced for a person to repeat, and the telephone will hear and speak it a hundred miles away in a tenth part of the time that the listener would need to utter it. Give a man a series of half-a-dozen notes to repeat, and he cannot do it accurately to save his life; but the iron plate takes them up, transmits them to another plate hundreds of miles off, which sings them forth instantaneously with absolute precision. The human machine can hear, and reproduce, in its way, only a single series of notes, while the iron ear of the telephone will take up whole chords and strains of music, and, sending them by lightning through the wires, its iron tongue will emit them in perfect relations of harmony."— Professor Youmans in the *American Popular Science Monthly*.

The London Stereoscopic Company have become sole licensees of Edison's phonograph in this country. they have, it is stated, paid for their right the sum of £3000, besides half the profits accruing from their use of it.

At the Crystal Palace on Good Friday the phonograph made its *début* before a miscellaneous audience. The instrument exhibited was made by Mr. Stroh, the well-known mechanician. The cylinder is driven by regulated clockwork instead of by hand, and the heavy fly-wheel necessary to give uniform motion in turning by hand is therefore discarded. A considerable number of people, including members of the newspaper press, assembled in the Opera House to hear the wonderful "talking machine"—as it is not very happily named. Mr. J. P. Edwards, of the Postal Telegraph Service, courteously undertook to explain the action of the instrument, and to superintend the giving of a variety of instructive illustrations of its powers. Instrumental music, songs, duets (recorded by means of a double mouth-piece), talking, and many other sounds, both odd and common, were faithfully rendered to the amusement and surprise of the audience. We understand that the Stereoscopic Company intend to continue the public exhibition of the phonograph at the Palace, and elsewhere throughout the country. Phonographs can be obtained from them at prices ranging from five to thirty guineas.

Edison's Patent, No. 2927, dated July 31, 1877, of which we give an abstract in the present number, serves to illustrate how an invention is generally evolved. In this patent, Edison describes a means of recording ordinary Morse signals by the indentations of a style on a sheet of paper enveloping a cylinder or plate with a V shaped spiral groove cut in its surface. The indented record so obtained was afterwards to be utilised, if required, in sending the same message automatically by means of the indentations. In this contrivance we have, to all appearance, the groundwork of the phonograph. The inventor's mind was prepared by it to receive the suggestion, which would germinate into a recorder and reproducer of actual sounds. This priceless seed is said to have been sown by accidents. While experimenting one day with a telephone, a style attached to the diaphragm, when it was vibrating under the voice, pierced Edison's finger and drew blood. We suppose the idea of the phonograph at once flashed upon him, for he saw that there was force enough in the style to record speech by indentations on a yielding substance, as in his preconceived telegraph apparatus. If this interpretation be correct, we may also draw the moral from it that no original idea is utterly worthless, and no good work is ever thrown away: for, at least, it may in time become the root of something better. Edison's indenting telegraph may never be practically applied, but it has borne wonderful fruit in the phonograph.

It is stated that the Edison Phonograph was suggested in 1865 by an Italian mechanic of the Val d'Aosto (Signor Manzetti), and published in the *Diritto* of Rome for July 10, 1865, and in the *Petit Journal* of Paris, for November 22, 1865.

EDISON AND THE COCKROACHES.—The Boston office was overrun with cockroaches, and Tom was much annoyed by them. With ready ingenuity he conceived and carried out a plan for their extermination. He tacked several zinc strips to the wall, at intervals of an eighth of an inch. He then applied the positive and negative poles of a battery alternately to the strips. He next smeared the wall above the strip with molasses. The roaches came up in platoons, very much after the manner of the British troops at Breed's Hill. As they stepped from strip to strip they "closed the circuit," received the full benefit of the electric shock, and dropped dead by scores. Tom used to catch their bodies in a water pail, and it is said that the bucket has been filled in a single night.—*New York Sun.*

IT is announced that Major Bateman-Champain has been appointed Director General of Telegraphs in India.

THE Brazilian Submarine Telegraph Company notify that the Lisbon and Maderia cable is interrupted, but as the fault is reported to be near the mouth of the Tagus, it is not anticipated that it will be of long duration. Until communication is restored, messages will be forwarded by post from Lisbon.

AGENTS from the British Government have arrived at Athens to make preparations for laying a special cable to connect the Sea of Marmora with Greece.

THE TELEGRAPH BILL.—This Bill, which was introduced into the House of Lords by the Lord Chancellor, is now issued. The definition "telegraph" is by it extended beyond the limits assigned in the Act of 1869, so as to include any apparatus for transmitting messages, or other communications, by means of electricity. Upon any difference arising between the Postmaster-General and persons or bodies having power to give or withold consent to the Postmaster-General placing telegraphs or posts in, under, over, or across a street, public road, estuary, railway, canal, &c., such difference as to consent shall be referred to arbitration. Power is taken by the present bill for the Postmaster-General to establish telegraphic lines on railways, tramways, roads, and similar undertakings authorised by special Act of Parliament after the commencement of the present year, subject to certain restrictions as to indemnifications to the owners for damage done, and prevention of obstruction, and a long series of provisions is made as to the course to be adopted in the case of interference with, or alteration of, telegraphic lines in the construction of works authorised by Act of Parliament.

AT a meeting of the City Commissioners of Sewers, in the Guildhall, on Tuesday, April 16th, Mr. Deputy White asked the Chairman of the Streets Committee what progress had been made with regard to the electric light. Mr. Bassingham said that the Committee had written to various Continental towns on the subject, and that answers from several of these had been received. He also mentioned that Mr. Boor was about to introduce a lamp, made by a Paris firm, which would be brought before the committee as early as convenient.

THERE are now nearly 10,000 miles of overland lines in operation in Australia.

ON Saturday, March 20th, after two days of hot oppressive weather, accompanied by magnetic storms, a sharp earthquake, was felt in Turkey. The shock to Admiral Hornby's flag ship was so great as to cause the alarm of a torpedo attack.

IT is intended to introduce into the naval service a new "torpedo battery gun," to be used in defending ships against the approach of torpedo boats.

M. MONGENOT has called the attention of the French Academy to a new telegraph of his invention, in which both the transmitter and receiver consist of two ivory plates carrying the disconnected ends of an open part of the circuit. The sender places this contrivance between his lips, and sends the message by talking or by closing the circuit by his lips, according to a code of signals. The receiver, holding the receiving apparatus similarly, interprets the message by the sensation he feels. This is an old idea, but may be cleverly worked out in this case. M. Mongenot claims to become a competitor for the Volta prize with it.

DIMINUTION OF MAGNETISM UNDER HEATING.—According to recent experiments of M. Gaugain, the decrease of magnetism in a magnet heated to a temperature of 300° or 400° C., is due not only to an enfeebling of the existing magnetism, but also to the development of opposite magnetism in the bar.

A NEW MANGANESE ELEMENT.—M. A. Gaiffe recently called the attention of the physical section of the French Academy to a new form of battery invented by him. It consists of a carbon cylinder, pierced with holes parallel to the axis, the holes being filled with binoxide of manganese, for the positive pole; and a zinc rod for the negative pole. The solution is formed of 20 parts of chloride of zinc, free from lead, and as neutral as possible, dissolved in 100 parts of water. The electro-motive force, resistance, and constancy of the cell, are said to be unimpaired by this substitution of zinc chloride for ammonium chloride. Oxide of zinc is formed, and falls in a state of powder on the bottom of the vessel. It is claimed for this cell that it does not produce double chlorides of zinc and of ammonium, which, in certain cells, incrust the porous pots, and stop their action. It is further held that the affinity of chloride of zinc for water checks the evaporation sufficiently to render the drying up of the cell very unlikely.

THE THERMO-ELECTRIC PROPERTIES OF LIQUIDS.—In a recent communication to the Royal Society, Dr. G. Gore, F.R.S., described an improved apparatus for

examining the thermo-electric properties of liquids, by the use of which, with the precautions stated, all sources of error in experiments on this subject appear to be removed. He also described a number of experiments he has made with it, and the results obtained. By employing a sufficient number and variety of electrically-conducting solutions, of acids, salts, and alkalies, in those experiments, he has discovered several exceptions to the usual effect he had formerly obtained, viz., that acid liquids are thermo-electro-positive, and alkaline ones thermo-electro-negative; and has sketched a diagram representing the thermo-electro behaviour of heated platinum in three of the exceptional liquids. Reasoning upon the satisfactory results obtained, he concludes:—1st. That the electric currents are not produced by chemical action; 2nd. Nor by a temporary dissociation of the constituents of the liquids; 3rd. Nor by the action of gases occluded in the metals; 4th. But that they are produced purely and solely by the heat, and that heat disappears in producing them; 5th. That they are immediate or direct effects of the heat, and that aqueous conducting liquids, therefore, possess, true thermo-electric properties; 6th. That the current is a result of a difference of thermic action at the surfaces of the two pieces of metal; 7th. That it is a product of a suitable molecular structure of the liquid, a change of such structure resulting from alteration of temperature, and a direct conversion of heat into electricity; and 8th. That the circumstance which is most influential in enabling heat to produce the currents, and most determines their direction and amount, is a suitable molecular structure of the *liquid*. By means of the apparatus and process described, he has discovered irregular molecular changes in several of the liquids examined; and as molecular changes are the bases of various physical and chemical alterations, he suggests the use of this apparatus and method as a new one for discovering anomalous molecular alterations, and other co-incident physical and chemical ones, in electrically conducting liquids; and for detecting differences of electric potential between metals and liquids at different temperatures. Dr. Gore also concludes as probable, that when a piece of metal is simply immersed in a suitable liquid, a change of temperature occurs; and this (if correct) is a parallel fact to that of the production of electricity by simple contact only. The results also support the contact theory of voltaic electricity. The paper concludes with several suggestions of new lines of research suggested by the experiments, one of which is the construction of a new thermo-electro-motor. Since writing his paper, Dr. Gore has proved by experiment, that when a sheet of platinum is immersed in various saline, alkaline, and acid liquids, a slight rise of temperature takes place.

The Electric Writing Company, of King William Street, are trying to introduce the Edison Electric Pen for writing the sums on cheques and notes indelibly by fine perforations and without ink.

A new Telegraph Apparatus, capable of transmitting and receiving a hundred and twenty, and under certain conditions even two hundred and fifty messages per hour, is reported from Vienna. It is the invention of Herr A. Eduard Granfeld, an Austrian telegraph official, and the experiments are said to be completely successful.

An Electric Zoophyte.—A correspondent writes to a contemporary pointing out the fact that the ordinary *Zoophytus Plasticus* has a large natural store of electricity which it is capable of discharging into the water after the manner of the electric eel. Shocks have been felt from it by persons bathing. The writer charged a small Leyden jar with the discharge, the electricity being positive. After several experiments the Zoophyte became visibly weaker, and died in a few hours.

A Determination of Siemens' unit of resistance. The *Philosophical Magazine* for January, February, and March, contains an account of an important determination, by Professor H. F. Weber, of Zürich, of the absolute value of Siemens' mercury unit of resistance, that is, the resistance of a column of pure mercury one metre high and one square millimetre in section. His results were obtained by three different methods, namely:—(1) from the variable currents generated by magneto-electric induction; (2) from the variable currents generated by sudden voltaic induction; (3) from the heat developed by steady voltaic currents. The ratios of Siemens' unit to the ohm or British Association unit, thus determined, were respectively 0·9545, 0·9554, 0·9550 to 1. The mean value of these is 0·9550, that is to say, one Siemens' unit = 0·9550 ohms. This result is only ⅓ per cent. higher than that obtained by the British Association Committee of 1864, which was composed of Professors Clerk Maxwell, Jenkin, and Balfour Stewart. The ratio as educed by them, and entered in our text books and telegraph manuals is 0·9536 to 1. In 1870, a determination by Professor F. Kohlrausch, made the ratio 0·9717 to 1; but this value was not accepted, at least in England. These experiments of Professor Weber may be held as confirming the value assigned to the ohm by the British Association.

A Constant Bichromate Cell.—In the *Philosophical Magazine* for March, Mr. H. C. Russell, of Sydney Observatory, describes a form of bichromate cell which he states to be perfectly constant in its action. It consists of a bichromate cell with the zinc plate standing in mercury, and the peculiar feature is that fresh bichromate solution is constantly fed into the top of the cell, drop by drop, while the waste solution is drawn off from the bottom, drop by drop. This is effected by a syphon arrangement which draws off the waste liquor from the bottom, drop by drop, as the level of the liquid in the cell is raised by the indropping solution: thus a constant level is maintained.

IN continuing his experiments on the reflection of a beam of polarised light from the surface of a magnet, Dr. Ker, of Glasgow, has obtained feebler but similar effects by reflection from the equatorial surface of the magnet as from the polar surface. The experiments only yielded perceptible results at angles varying from 85° to 30°. The law of the magneto-optical action involved in these experiments may be stated as follows:—Whatever the angle of incidence between grazing and normal, the effect of magnetising the mirror is to turn the plane of polarisation of the reflected light through a very small angle, in a direction always contrary to that of the hypothetical currents of Ampere supposed to cause the magnetism. When the plane of incidence of the polarised ray was perpendicular instead of parallel to the lines of magnetic force, no optical effect of magnetisation could be perceived.

LORD ODO RUSSELL has conferred with the Post-master-General Stephan of Germany, concerning the postponement of the Telegraphic Congress to June 1879.

THE *Standard* hears that the Government are about to extend the means of telegraphic communication in the Mediterranean.

IN *Cassell's Family Magazine* for May is to be found a paper descriptive of a supposed "Conversazione of Telegraph Engineers." Under the light veil which the writer has thrown over them we recognise one or two well-known professional figures.

A TELEGRAPH TO LUNDY ISLAND.—On Thursday, April 19th, at a meeting of the Cardiff Shipowners' Association (at which Swansea and Newport were also represented), it was resolved to form a company to connect Lundy Island (from the south-east corner) by telegraph with the mainland at Hartland, and thence with the Government wires. It was estimated that the expense of laying the cable, erecting a signal station, &c., would be £5,500. The working expenses were put down at £300 a year, and it is anticipated that the company can be worked at a profit. The capital of the company will consist of £10,000 in 1,000 shares, and two-thirds of the capital will be called up. About 160 shares were taken up in the room, and a working committee of representative gentlemen at Cardiff, Swansea, Bristol, Newport, and Gloucester was formed. —*Engineering.*

THE Scilly Islands line having been purchased by the Post Office, and the cable connecting Scilly with the main having been repaired, messages between Scilly and other parts of the United Kingdom are now forwarded by telegraph to their destination there at at the ordinary inland rate.

EDISON'S TELEPHONE.—On April 2nd, a successful trial of Edison's carbon telephone was made between New York and Philadelphia, over one of the many lines of the Western Union Company traversing this distance. The line in question was 106 miles long, and ran for most of the way beside other wires passing underground in New York to the W. U. office. The induction disturbances from the working of the neighbouring lines were considered sufficient to obliterate the articulation of any other telephone but Edison's. Two cells and a small induction coil were used to operate it. A number of gentlemen, including the late President Orton of the W. U. Company, Mr. Edison, Mr. Phelps, and Mr. Batchelor, who is Mr. Edison's chief assistant. Edison, in New York, conversed freely with Mr. Batchelor and Mr. Phelps in Philadelphia. Phelp's magneto telephone, which is, perhaps, the most powerful of its class, was also tried; but although words and occasional sentences were transmitted, it did not give the satisfactory results given by Edison's.

Patents.

1326. "Improvements in interlocking apparatus for the points and signals, and telegraphic block instruments of railways."—C. HODGSON, April 4.

1370. "Telephones."—A. PARIS, April 6.

1419. "Apparatus for transmitting messages."—M. T. NEALE, April 9.

1467. "Method of originating and developing electric currents."—N. C. SPALDING, April 12.

1519. "An apparatus for raising ships, anchors, chains, telegraph cables, and other property sunken in the sea, or rivers, or lakes."—N. SCHALLEHN, April 16.

1522. "Elements or parts of galvanic batteries."—P. GRABINGER, April 16.

1564. "Improvements in apparatus for igniting and extinguishing gas by electricity; parts of which improvements are applicable in the employment of electricity for other purposes."—W. R. LAKE (communicated by J. W. Bartlett), April 18.

1587. "Improvements connected with means or apparatus for the production, application, and regulation of electric currents."—J. L. PULVERMACHER, April 20.

1613. "Improvements in transmitting and receiving telegraphic messages or signals, specially applicable to field telegraphy, and in apparatus for the purpose."—J. B. G. MANGENOT, April 22.

ABSTRACT OF PUBLISHED SPECIFICATIONS.

2538. "Electric telegraphs."—J. and A. MUIRHEAD, July 2nd, 1877. 10d. This relates to Muirhead's artificial cable (Patent No. 3663 of 1874) and various devices for employing it in duplex working on submarine cables. It consists in employing lengths of the inductive resistance or artificial cable in place of the differential resistances employed in duplex systems of working. Also in effecting a balance without the need of a full artificial or compensating circuit, and thereby saving apparatus, by connecting the receiving instrument with some part of the compensating circuit which will obviate any "kicks" or momentary currents on it due to sending.

2696. "Telegraph apparatus."—LAURENTIUS CARLANDER, Stockholm, July 12, 1877. 2d. This consists of an automatic transmitter and puncher for the paper. *(Not proceeded with.)*

2880. "Telegraphic apparatus."—HENRY GARDNER, July 27, 1877. 6d. This consists of a semi-automatic

signalling key, whereby the sender has not to consider the relative duration of dots and dashes. Two contiguous keys, one for dots and dashes, are employed. These keys are connected by two vertical rods to a double-branched interruptor lever, the lowering of which determines the contact which closes the circuit. The ends of the two branches upon which the rods of the key act are furnished with distinct appendages so combined that the oscillation of the interruptor lever is effected differently, according as it is desired to produce a short or a long contact. *(Not proceeded with.)*

2889. "Electro-magnetic apparatus."—J. N. H. BOUCHER, Paris, July 28, 1877. 2d. This consists of electro-magnetic jewellery and articles of attire designed for the remedy of certain diseases. These are termed the "Volta-Boucher" apparatus for winter and summer. Ear pendants of different metals, with a tail or end piece to be introduced into the ear; rings composed with a view to act more or less energetically, and placed one, two, or three on each hand, but of necessity alternately, for example, one on the thumb, the second on the middle finger, the third on the little finger, so that the fore-finger and fourth finger serve as separators; spectacles having the frame made of different metals; bonnets or head-dresses; belts, garters, and a "dalmatic" dress of Boucher fabric are the specialties described by this invention. The latter is an electro-magnetic shirt provided with a galvanic chain at the upper part, a mouth-piece to be inserted in the mouth, another to be fixed in the anus; and if the dress only extends to the thighs a chain may be employed for the legs with a ring at the end to be secured to the big toe. *(Not proceeded with.)*

2892. "Stopping runaway horses."—PIERRE RONDEL, Paris, July 28, 1877. 2d. This consists in administering a shock to runaway horses to compel them to stop. A Ruhmkorff coil, or electrical machine, under the driver's control generates the shock which travels by wires along the reins, and is passed through the nostrils of the horse. *(Not proceeded with.)*

2909. "Controlling by sound the transmission of electric currents, and the reproduction of corresponding sounds at a distance."—T. A. EDISON, New Jersey, U.S. This describes Edison's well-known telephonic apparatus with the transmitter based on the varying resistance of plumbago under pressure, and the receiver based on the alteration in the friction of certain surfaces by the passage of an electric wave between them.

2934. "Electric lamps."—SIEGFRIED MARCUS and BELA EGGER, Paris, July 31, 1877. 8d. This relates to a regulator for the electric light. The carbon points are so supported through the medium of a pulley that they move together or apart simultaneously. They are counterpoised or balanced round this pulley so that a slight rotation of the pulley in one direction or the reverse approaches or recedes both the carbon points simultaneously. This regulating motion is obtained from the current through an electro-magnet with a moveable core in its centre. This moveable core is suspended from one of the carbon points, that is to say, from the pulley, and acts as a counterpoise to the other carbon point also supported by the pulley. When the arc between the points is of proper length this suspended core takes up a certain position in the electro-magnet; but when the arc is too short or too long the current is too strong or too weak, and the core is pulled down or let up within the electro-magnet and this movement rotates the pulley until the points are adjusted to their proper relative positions.

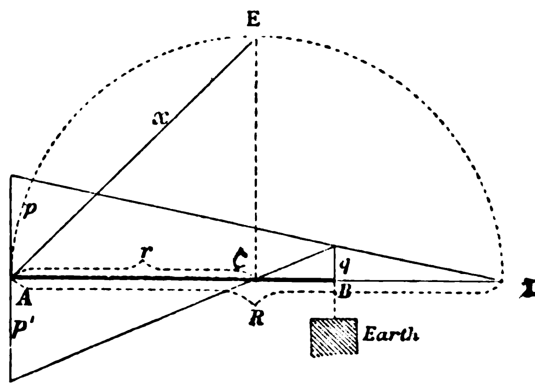
2927. "Instruments for transmitting telegraph messages."—THOMAS ALVA EDISON, New Jersey, U.S. Dated July, 31. 2d. This consists of a means of recording messages, so that the message may be used to transmit upon another circuit. The record is made by indentations along a volute line on a disc grooved to correspond, or along a zig-zag groove on a cylinder. The paper is put upon the disc or cylinder in a predetermined position, regulated by register marks, so as to be held accurately in place, and the indenting point is upon an arm or slide kept in position by a corresponding groove, or volute, or otherwise, so that the indenting point is always over the groove, and will indent the paper down into the groove when the point is pressed upon the paper. The point is operated by an electro-magnet. The idented record of the message obtained on the paper is used automatically to transmit the message afterwards on another line.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—In your issue of November 15th, 1877, you published a formula by Mr. Ch. Dresing, "for calculating the copper-resistance during electric disturbances (earth currents)", and in the number of the TELEGRAPHIC JOURNAL for December 1st, Mr. Dresing writes again regarding the simplicity of this new formula. To these two articles Professor Ayrton has drawn my attention, remarking that in obtaining the formula, Mr. Dresing appeared not only to have neglected the resistance of the testing battery, but also to have assumed that the resistance of one or both of the arms of the Wheatstone's bridge was extremely small, and in addition, that in the formula the unknown resistance, as given by the geometric mean of the observed values, could only be true in the few cases when it was also equal to their arithmetic mean. I have, therefore, examined the question, and, for the benefit of students like myself, beg to forward my conclusions so that, should I have misunderstood Mr. Dresing's communications, he will do me the favour to correct my false impression.

Fig. 1.



First, however, I would suggest that the following may be the answer to your query in the December number "How can Mr. Schwendler's formula give too low a result?" The *first* formula for x on page 29, Clark and Sabine's Electrical Tables, is a *mathematically*

correct one, and therefore, as you remark, if properly worked out, it must give the exact value of x. But I think the formula practically used, and the one therefore probably which Mr. Dresing refers to, is not the first complicated (but at the same time complete) one, but the *second* form to which the first reduces itself when we neglect the battery resistance. Now the reason why this second formula gives a result smaller than the truth, is comparatively simple. Since the first formula may be written in the form—

$$x = \frac{b}{a}\left\{\frac{w' + w''}{2} - \frac{(w'' - w')^2}{2(w' + w'') + 4f\left(1 + \frac{a}{b}\right) + 4a}\right\},$$

where w′ and w″ are the values obtained when testing with the positive and negative currents, we see that neglecting f, the battery resistance, increases the value of the second term, and therefore diminishes the value of the whole expression. Consequently the second formula for the value of x, the one in which the battery resistance is neglected, gives an answer always *smaller* than the truth.

With respect to the diagram given by Mr. Dresing, fig. 1 in this letter, how does he know that A E represents x, the true wire resistance of the line? Does not A B represent x as A C* and A D represent r and R respectively? It is clear that A E is the geometric mean of r and R, but why it represents x is not evident. Further, it may easily be shown that A B equals $\frac{2Rr}{R+r}$, for

$$\frac{p}{R} = \frac{q}{R - AB},$$

and

$$\frac{p'}{r} = \frac{q}{AB - r},$$

therefore, since $p = p'$, we have

$$AB = \frac{2Rr}{R+r},$$

But $\frac{2Rr}{R+r}$ is not equal to $\sqrt{Rr}$ unless R and r are equal to one another, or unless A B equals $\frac{R+r}{2}$; consequently A B cannot equal A E generally.

Again, it must be remembered that Mr. Dresing's figure only represents the potential curve in a small portion of the bridge, the complete curve being shown in fig. 3 of this letter, S A representing b in fig. 2, A B standing for x, A C and A D the apparent values obtained when testing with the positive and negative currents. Now, if the resistance of the battery be small, P and P′ in fig. 3 will be equal, but not p and p', which are the same as p and p' in figure 1. And the only case in which p and p' will be equal (which Mr. Dresing appears to assume always to be the case) will be when S A, or b in fig. 2, is nought, a condition that would only be fulfilled when a single platinum wire bridge (such as was employed by the British Association Committee) is made use of. But such a bridge is well known to be very unsensitive when measuring large resistances, such as those of telegraph lines.

The correct graphical proof of Mr. Schwendler's formula is given by Mr. F. Jacob in your Journal for October 1st, 1876, where he arrives at the result

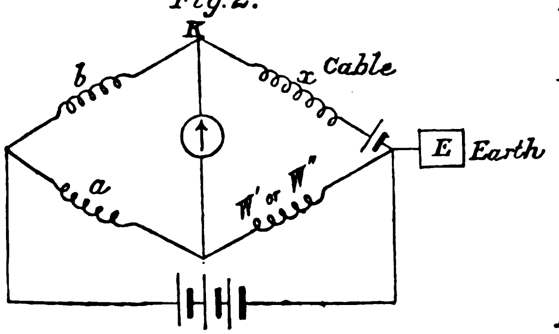
$$x = \frac{b}{a}\left\{\frac{w' + w''}{2} - \frac{(w'' - w')^2}{2(w' + w'' + 2a)}\right\},$$

which is the same as that given by Messrs. Clark and Sabine when the battery resistance is neglected. Now if in this last equation

$$b = a = \text{a very small quantity,}$$

under which latter hypothesis only is Mr. Dresing's figure correct,

Fig. 2.



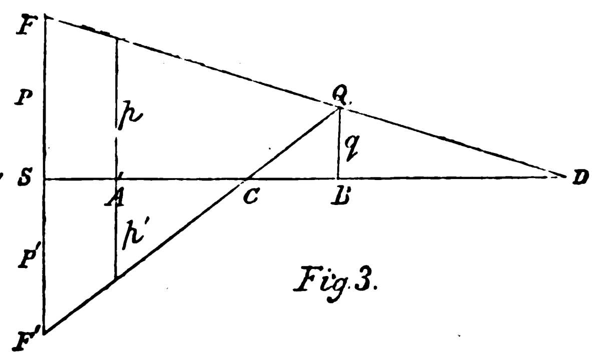


Fig. 3.

$$x = \frac{2w'w''}{w' + w''}$$

which you will observe is the value I obtained above directly from the figure in question. But, as already mentioned, this can only reduce itself to $\sqrt{w'w''}$ either when w′ equals w″, or when

$$x = \frac{w' + w''}{2}$$

It therefore seems as if Mr. Dresing's geometrical mean formula, which he proposes to use in all cases when there are strong natural currents in the line, can be used—first, only when the natural current is very weak; secondly, only when the resistance of both branches of the Wheatstone's bridge is very small.

I have the honour to remain
Your obedient servant,
J. FUJIOKA,
Student of Telegraph Engineering.

The Physical Laboratory,
The Imperial College of Engineering,
Tokio, Japan. February, 1878.

* C has been accidentally omitted in the Fig., it should be the centre of the circle.—EDIT. TEL. JOUR.

L. V. F.—Duly received with thanks.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

(Continued from page 171.)

In France, a few years ago, an insulator of a very inferior character was employed. Since then, however, the French have assimilated their systems to those of other European countries, having adopted a form of double-cup insulator for all important circuits, and one with a single cup for less important lines, viz., for lines varying from 50 to 200 kilomètres in length.

In Spain, Siemens' insulators were, until recently, almost wholly employed, but now the Prussian pattern, slightly modified, so that a groove in the top of the insulator supports the wire, is used. The groove is necessary, because in that country the old system of winders is still in existence. Insulators of the Prussian form, fitted on the upper extremities with two winding drums, are placed at intervals of one kilomètre apart, the line wire running loosely through the grooves in the intermediate insulators.

In America, glass, as has already been mentioned, is almost wholly employed. The form mostly adopted consists of a single glass cup, in shape somewhat similar to the outer cup of a Varley's insulator. The interior of the cup is fitted with a female screw, into which is fixed a wooden pin, which supports the insulator.

An insulator called the Kenosha, consisting of white wood saturated with an insulating compound, the top protected with a metal cup, has likewise been somewhat largely used.

Brook's insulator consists of a cylindrical iron case, in which is inserted a blown glass bottle of peculiar form. Inside this is fastened a pin, which, terminating in a species of double hook, forms a support for the wire. It is claimed that a surface of blown glass, which is cooled by air contact alone, offers particular advantages in resisting deposits of moisture and dirt. This insulator has given some very good results, but it has not been practically tried in Europe against the forms in general use.

Testing.—The following is the method of testing at the chief factory of the Post Office in London.

All insulators are deposited in tanks, and filled with water, both inside and out, to within three-quarters of an inch to the lips. To prevent surface leakage, which would always exist in damp weather, they are kept dry on the edges by the heat of numerous jets of lighted gas, placed just above them, or the same result may be obtained by keeping the atmosphere of the testing-room artificially dry by means of hot-water pipes. After soaking for twelve hours, they are tested by means of a Thomson's galvanometer and 140 Daniell's cells. An ingenious combination of three keys and shunts is employed. In the normal position the galvanometer is short circuited. On depressing No. 1 key $\frac{9999}{10000}$ of the current is shunted from the instrument. No. 2 key introduces a shunt of $\frac{99}{100}$, and No. 3 gives the full current. If a deflection be given with No. 1 key, the insulator is at once rejected, unless the lips are observed to be wet. If the latter be the case, or if deflections be given on depressing keys No. 2 or 3, the insulator is marked, and subsequently dried and carefully re-tested. Should any leakage still be shown, it is then finally rejected. By this means all defects of manufacture or accidental flaws, are inevitably detected before the materials are passed into actual employment.

In France a somewhat similar system is adopted, the standard being 7,000 megohms.

A series of experiments had been carried out by Mr. Gavey in which the insulation of various sections of line had been compared with the hygrometrical condition of the atmosphere, and from which it appeared,

First, that there is as it were a great wave of moisture that sweeps daily over the land, having its maximum near midnight, and its minimum at noon; and that accordingly the insulation of our circuits, generally low from 7 to 9 a.m., rises to a maximum from 11 a.m. to 3 p.m., then abruptly falls, reaching a minimum between 7 p.m. and midnight.

Secondly, that very frequently the most abrupt changes in insulation take place in a most limited time; the resistance dropping from several megohms to a fraction of a megohm per mile in the course of an hour or two.

Thirdly, that the resemblance between the insulation and moisture curves is very remarkable; so much so, in fact, that it is not improbable that an extended series of insulation readings would form a more accurate register of moisture over any given extent of country than ordinary hygrometrical readings.

Further experiments had been made in which the various forms of insulators were compared among themselves. The subjoined table gives the result of these trials.

When considering the advantages of any description of insulator, it is evident that one may have a better form for insulation under all circumstances than another of an inferior shape, but it may give an equal or lesser absolute resistance, owing to the latter having a greater length, or lesser section than the former. It therefore becomes desirable to reduce the absolute results, obtained in a series of tests for such as those recorded, to an unit result, so that a clear conception of the value of form may be obtained, and, if necessary, increased length or diminished section be applied to get the best results. This is done in the table in the following manner. The lengths of each cup are divided by the mean circumference, both inner and outer, and the absolute resistances are multiplied by the fraction—length by circumference—to give the "reduced" or "form" resistance of each insulator.

TABLE.

AVERAGE OF 23 TESTS OF 10 INSULATORS OF EACH DESCRIPTION.

Description.	Average Resistance, absolute.	Order of Merit.	Reduced Resistance.	Order of Merit.
Porcelain D.S. P.O. large New ..	13374·8	1	9302·9	1
Johnson's and Phillips' No. 5 ..	5428·6	2	5428·6	2
Johnson's and Phillips' Iron-capped	1346·6	3	1346·6	3
Porcelain D.S. Iron-capped ..	166·088	4	137·603	4
Porcelain D.S. Andrew's Old ..	56·004	5	41·36	5
Porcelain D.S. P.O Terminal ..	52·71	6	39·381	6
Porcelain D.S. Fuller's and Langdon's	45·426	7	25·363	11
Porcelain D.S. P.O. Form ..	41·988	8	29·32	8
Porcelain D.S. Prussian Form ..	41·651	9	26·14	10
Porcelain D.S. Andrew's New ..	41·214	10	36·802	7
Earthenware D.S. Varley's ..	32·040	11	28·9	9
Porcelain D.S. Fuller's Cone ..	31·08	12	17·695	13
Earthenware S.S. P.O. Form ..	31·059	13	17·341	14
Porcelain D.S. Corrugated ..	25·524	14	15·70	15
Porcelain D.S. Indian Form ..	25·376	15	12·919	19
Porcelain D.S. P.O. Form ..	20·284	16	14·168	16
Porcelain D.S. Schomburg's Short	19·089	17	23·62	12
Porcelain D.S. Schomburg's Varley's Form	13·039	18	9·90	18
Porcelain S.S. Schomburg's Varley's Form	12·013	19	13·757	17
Porcelain D.S. Terminal.. ..	0·912	20	10·643	20
Porcelain S.S. P.O. Form ..	13·880	21	5·82	21

PHYSICAL SOCIETY.—APRIL 13th, 1878.

Prof. A. B. CLIFTON, Vice-President, in the chair.

The following candidates were elected members of the Society:—W. Campbell, R. W. F. Harrison, Rev. S. N. Hutchinson, M.A., B. W. Richardson, M.B., F.R.S.

The SECRETARY read a paper by Messrs. J. Nixon and A. W. Heaviside, describing their experiments on the mechanical transmission of speech through wires or other substances, to which Mr. Preece had referred at a previous meeting of the Society. After describing a number of experiments in which metallic discs soldered on to the ends of the conducting wires were employed, they went on to enumerate the more successful experiments in which wooden discs were mainly employed. The first actual transmission of speech was effected by placing the belly of a violin against the receiving end of the wire, when every syllable spoken was distinctly audible. Very good results were obtained by employing mouth and ear pieces, formed as in a telephone, the disc being replaced by thin wooden discs six inches in diameter, and a No. 4 wire was found to be most satisfactory. On suspending a length of this wire in such a manner that it had no rigid attachments, it was ascertained that 120 yards is the limit through which a conversation can be carried on.

Captain ABNEY, F.R.S., described the method he adopted for photographing the least refrangible end of the spectrum. He pointed out that it is impossible, with the ordinary sensitive salts employed in the usual way, to photograph further than the Fraunhofer line E; though, by a preliminary exposure to light of a Daguerreotype plate, Draper is able to photograph beyond the extreme limit of visibility in the red end of the spectrum. This method, however, gave what is known as a reversed picture, the lights and shades being transposed, besides requiring a lengthened exposure. It enabled Becquerel to photograph the spectrum in its natural colours; and, later, St. Victor obtained coloured images of coloured cloths. The object of Captain Abney had been to obtain unreversed pictures of this portion of the spectrum, in other words, to obtain a compound that would be similarly sensitive to the red and the blue components of white light. Such a compound he had at last obtained by what he termed *weighting* silver bromide with resin, and now he obtains it by causing the molecules of silver bromide to weight themselves. He showed an ordinary bromide of silver plate, and the colour of the transmitted light was of a ruddy tint, showing absorption of the blue rays. Another film was shown containing weighted bromide of silver, which transmitted blue light and absorbed the red. Photographic plates prepared with the latter compound he showed were sensitive to the red and ultra-red waves of light; and he threw on the screen photographs of the spectrum from the line C to a wave length of 10,000, the ultra-red showing remarkable groupings of lines. He further showed that by friction the blue film was changed to the red, and in that state was not sensitive to the lower part of the spectrum. These photographs were taken by means of a diffraction grating, and Captain Abney demonstrated Fraunhofer's method of separating the various orders of spectre produced by it. He then explained that recently he had elucidated the reason of the reversal of Draper's pictures by the least refrangible end of the spectrum. He finds that it is accelerated by exposing the plates in weak oxidizing solutions, such as those of hydroxyl, bichromate of potash, permanganate of potash, and nitric acid, or exposure to ozone. The red rays, in other words, seemed to oxidize the photographic image, and to render it incapable of development.

Mr. H. BANERMAN then exhibited some paper models, illustrative of the disposition of the planes of symmetry in crystals. These included octants of the sphere with enclosed cube and octahedron faces pointed into their corresponding hexakis-octohedral faces; a cubic skeleton built up from nine planes of symmetry with a removable outer shell, and a system of axial planes of an unsymmetrical mineral enclosing a solid nucleus contained between three parallel pairs of planes. They were constructed for the purpose of showing popularly the difference between planes of symmetry and other diametral planes by laying upon them a small mirror or plate of mica, when, in the first case, the nucleus gave a symmetrical image corresponding in position to the plane immediately behind the mirror, but in the second a broken image is produced.

Dr. GUTHRIE exhibited the arrangement of apparatus he had employed in conjunction with his brother, to ascertain the effect of heat on the transpiration of gases. The main difficulty connected with the research was the securing of an absolutely constant pressure on the air operated upon. This was secured by inserting into the neck of the vessel, which served as an air-chamber, a tube turned up at its inner end, and terminating externally by a small funnel. As the tube was kept constantly full of water, the funnel overflowing, a pressure, represented by the difference between the heights of these levels, was maintained. After passing through a series of drying tubes, the air traversed the (V-shaped) capillary tube in a beaker containing water of known temperature, and was finally received in an inverted tube contained in an overflowing dish of water. Among other results it was found that the resistance of a tube is the same as that of its several portions; and if t be the time occupied, T the absolute temperature, p_1, p_2 the pressures, and a & β constants, they find that $t = a\,T \left(\frac{T + \beta}{p_1 - p_2}\right)$

THE INSTITUTION OF CIVIL ENGINEERS.

AT the meeting on Tuesday, the 9th of April, Mr. Bateman, President, in the chair, the Paper was on "The Embankments of the River Thames," by Mr. Edward Bazalgette, Assoc. Inst. C.E.

The first Commissioners for embanking the Thames were appointed in 1367. Acts for constructing embankments and improving the navigation were passed in the reigns of Henry VIII. and of Elizabeth. Sir Christopher Wren proposed an embankment from the Temple to the Tower, after the fire of 1666. Sir Frederick Trench and Mr. Martin suggested similar embankments. In 1840 Mr. James Walker laid down a line for a northern embankment for the Corporation of London, to be raised 4 feet above Trinity High Water. His line and levels had since been adopted. Various Parliamentary Commissions and Committees had considered the subject. In 1862, an Act was obtained by the Metropolitan Board of Works for the formation of the Victoria Embankment, from Westminster to Blackfriars Bridge. In 1863, another Act was passed for the construction of the Albert Embankment, from Westminster to Vauxhall Bridge. And, lastly, in 1868, the Act for the Chelsea Embankment, from Chelsea Hospital to Battersea Bridge, was sanctioned. These embankments comprised about 3½ miles of river wall, and had reclaimed 52 acres of land.

The Victoria Embankment, about ¾ mile long, cost £1,200,000, besides £450,000 paid for the purchase of property. The foundations of the retaining wall of the embankment were put in behind cofferdams, made in some places of timber and in others of oval wrought iron caissons.

The bottom portions of the iron caisson cofferdams

were filled with concrete, and left in the ground permanently, and the piles of the wooden cofferdams were cut off under water at various levels, in both cases to protect the toe of the wall. The upper portions of the caissons were in half rings, and were capable of being used several times. Both the iron and timber cofferdams were supported by timber shoring from the land side. The caissons were sunk by weighting them, and excavating within them by three methods: 1, by men working inside, the water being kept down by pumping; 2, by men working within, the water being excluded by pneumatic pressure; and 3, by a telescopic dredger, the water being allowed to rise and fall within the cylinders. By the first plan 6 cubic yards, by the second 5·31 cubic yards, and by the third 10 cubic yards of material were excavated per diem. Again, according to the first system, a cylinder was sunk on an average in eight days and a-third, and the labour cost 14s. 6d. per cubic yard. By the second, a cylinder was sunk 20 feet in eleven days and a-half, and the labour cost 12s. per cubic yard. By the third, a cylinder was sunk in less time at a cost of 8s. per cubic yard for labour.

The foundations rested on clay, and were made of Portland cement concrete, on which the retaining wall was built of brickwork faced with granite. A sewer and a subway for gas and water pipes was formed in the retaining wall; and the Metropolitan Railway was constructed under the roadway along the whole length of the embankment. The Albert Embankment cost £309,000, and was about 4,300 feet long. Timber alone was used for the cofferdams in constructing this embankment, and the retaining walls were partly made of concrete, instead of brickwork, with a facing of granite. Opposite Millbank the river was widened from 600 to 720 feet for a length of 600 feet. The Chelsea Embankment, commenced in July, 1871, and completed in May, 1874, was over ¾ mile in length. The embankment wall was composed of concrete, faced with granite; a sewer for carrying the sewage from Hammersmith was constructed behind it. The cost of the works was £134,000.

In the discussion which followed the reading of the paper, and which occupied the whole of the time at the meeting on Tuesday, the 16th April, and in which Mr. Abernethy, Mr. Shelford, Sir J. Bazalgette, Mr. Redman, Mr. Shield, Mr. Giles, Mr. Latham, Mr. Law, and Mr. Scott-Russell, took part; the causes of the increased rise of tide, which has occurred of late years above London Bridge, were mainly dwelt upon. It was considered by most of the speakers that the embankments had little or no effect upon the tide, but that the observed rise was almost entirely due to the removal of old bridges, and the improvement of the channel both above and below London Bridge by dredging, whereby a larger volume of tidal water was admitted up the river, and also to the extension of arterial and subsoil drainage, which brought the flood waters down more rapidly and in greater volumes within a given time. It was admitted that experience showed that five feet, instead of four feet, should be adopted for the height of the embankments above Trinity high water mark. Mr. Abernethy considered that in cofferdams simplicity of construction and rapidity of execution were the main objects, and that in both these respects timber cofferdams were preferable to iron caissons. Sir. J. Bazalgette explained that the iron caissons had been used where the foundations had to be carried to the greatest depth, and that by using them they had been enabled to place the foundations at a higher level than would have been safe with a timber dam. He mentioned that the failure which had occurred along a short length of the Chelsea Embankment, was due to the removal, by the Thames Conservancy, of a portion of the pilework foundations of an old pier which stood in front of it. There was a general concurrence of opinion expressed that the Thames Embankments were amongst the finest works adorning the metropolis, and that such works, designed solely with a view to the public good, could only be carried out by a public body by means of public funds.

THE METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this society was held on Wednesday, the 17th instant, at the Institution of Civil Engineers, 25, Great George Street, Mr. C. Greaves, President, in the chair. Mons. Marié Davy, Capt. N. Hoffmeyer, Prof. D. Ragona, and Dr. A. Wojeikoff were elected honorary members. The discussion on "Waterspouts and Globular Lightning," which was adjourned from the last meeting, was resumed and concluded. The following papers were then read:—

"On the application of Harmonic Analysis to the reduction of Meteorological Observations, and on the general methods of Meteorology," by the Hon. R. Abercromby, F.M.S. The meaning of harmonic analysis is first shown, in reference to average barometric pressure, by tracing the geometrical and physical significance of every step from the barogram till the tabulated results are combined in an harmonic series. It is then shown that, whether we regard this series simply as an algebraic embodiment of a fact, or as a series of harmonic components, as suggested by Sir W. Thomson, it is simply a method of averages, and our estimate of its value must depend upon an estimate of the use of averages at all in meteorology. It is then pointed out where averages are useful, and their failure to make meteorology an exact science is traced to three causes. (1.) That the process of averaging eliminates the variable effects of cyclones and anticyclones, on which all weather from day to day depends; and on this are based some general remarks on the use of synoptic charts, not only in explaining and forecasting weather, but in attacking such problems as the influence of changes of the distribution of land and water on climate, and the cyclic recurrence of rain or cold. (2.) That deductions from averages only give the facts, and not the causes, of any periodic phenomena. The position of diurnal and other periodic variations in the general scheme of meteorology is then pointed out, and it is shown that their causes can only be discovered by careful study of meteorograms from day to day. (3.) That in taking averages, phenomena are often classed as identical, which have really only one common property. For instance, rain in this country is associated with at least three different conditions of atmospheric disturbance, and it is necessary to discriminate between these kinds before meteorology can be an exact science.

"On some peculiarities in the Migration of Birds in the Autumn and Winter of 1877-78," by J. Cordeaux. Mr. Symons gave a verbal description of the recent heavy fall of rain on April 10th and 11th, the greatest amount known to have been registered, being 46. inches at Haverstock Hill.

General Science Columns.

GANGES CANAL HEAD WORKS.

AT the point where the Ganges Canal takes its supply from the Ganges, that river has five channels, two of which are closed, thus forcing the stream to run in the three remaining channels. The bands constructed to direct the river to the canal head are made, some of boulders, and some of cribs filled with boulders. All

these bands are carried away every rainy season, and have to be reconstructed during September and October. Of late years, the increase of canal irrigation made the demand for water so great and so constant that it was determined to build a permanent bar across the entire river at the general level of the cold weather bed. This plan had been tried with success on two of the river channels. At this time the deep channel and main force of the river were on its left bank, and it was the unanimous opinion of the canal engineers that the river should be kept as much as possible on the right bank, and it was accordingly determined to commence the construction of the bar from the left bank, in hopes of driving the river towards the right. A length of 300 feet was built in 1864, and had the expected result. In 1874 the length of the bar had been increased to 590 feet; after the rains this length was found to be shingled up, and the force of the river passed beyond its right flank. In 1876 a further length of 290 feet was added, making the total length of the bar, from its left flank, 880 feet. It now became evident that the limit to such extensions of the bar from the left only had been reached, for the river was thrown with so much force on to the right bank that the destruction of the island between two of its channels was threatened, and it was therefore determined that, before next rains, the bar must be completed across the Ganges, and the nose of the island threatened be made strong enough to resist the full force of the river. This has now been done, and although last year's floods were so slight that the work cannot be said to have undergone the test of an average rainy season, from what was seen, full confidence is expressed that it will prove quite successful.

SCANDINAVIAN RAILWAYS.

There are throughout Scandinavia 49 lines of railway in operation, having an aggregate length of 5,651 kilometres. Of these, 41 lines are in Sweden, with a total length of 3,907 kilometres; in Norway there are six lines, 587 kilometres in length; and in Denmark two lines, with a united length of 1,157 kilometres. The capital employed in the construction of the Swedish lines has been 402,157,919 francs. During the year 1876 the traffic carried consisted of 6,880,893 passengers, and 4,503,886 tons of merchandise; the total receipts amounted to 38,714,018 francs, and the expenses to 23,576,092 francs. The Norway lines have cost 57,088,984 francs, and during the year their traffic comprised 1,588,769 passengers, and 893,971 tons of merchandise, realising gross earnings amounting to 5,787,294 francs, whilst the expenditure was 4,358,918 francs. In Denmark the railways have cost 142,198,671 francs; the traffic for 1876 was 5,904,545 passengers, and 871,181 tons of merchandise, yielding 14,487,726 francs gross revenue, with expenses amounting to 9,018,807 francs. Analysing these figures a little further it appears that the cost per kilometre of railway in the three kingdoms has been as follows: Sweden, 102,933 francs; Norway, 97,255 francs; and Denmark, 122,903 francs. The net returns were 15,137,926 francs, 1,428,376 francs, and 6,468,919 francs respectively, yielding returns upon the capital outlay in each case of 3·76, 2·5, and 4·54 per cent.

Sewage in the Thames.—At the beginning of the year we referred to the report presented by Captain Calver, in December last, to the Thames Conservancy, as to the polluted state of the Thames, and the deposit of sewage in the neighbourhood of the metropolis. At the last meeting of the Metropolitan Board of Works, a report was presented from Sir J. Bazalgette and Messrs. Law and Chatterton, in reply to Captain Calver's report. The conclusions at which they have arrived are as follows :—

"1. That we have shown that there is no documentary evidence to prove that foul and offensive accretions have recently formed within the channel of the Thames, but, on the contrary, that the condition of the river is gradually improving, more especially as regards the depth of its channel. 2. That a true interpretation of the analyses quoted by Captain Calver proves, as is the fact, that both the water and mud of the Thames have improved greatly in purity since the sewage has been diverted from the metropolis to a point lower down the river. 3. That these same analyses show that there is no resemblance whatever between sewage mud and Thames mud, and therefore, that Thames mud cannot be derived from sewage. 4. That there is no evidence whatever which supports the statement that the sewage works its way up the river, and that such statement is contrary to the fact. 5. That the present muddy condition of the river is caused principally by the unprotected state of its banks, which in many parts are being rapidly washed away, and which are the result of a neglect of the duty which legislation has cast upon the Thames Conservators."

It will be seen that the opinions expressed in this report are diametrically opposite to the conclusions at which Captain Calver arrived; and the blame of the present polluted state of the river is thrown back on the Conservancy. The conflict of evidence brought forward by the two opposing parties is complete; and till some independent evidence is forthcoming, the question at issue must remain undecided.

The Ordnance Survey.—We are glad to learn that the whole staff of ordnance surveyors is to be employed in England this year, the field survey of Scotland having been completed last year. The one inch to a mile ordnance maps of England were completed several years ago, but a very small portion of the six inch and twenty-five inch maps have been published; and, useful as the one inch maps are for many purposes, the larger scales are urgently needed by landowners, engineers, and surveyors. We think that much more rapid

progress ought to have been made with the survey; and, in this instance, Irish interests cannot be said to have been neglected, as the whole survey of Ireland has been completed and published in the three scales some years ago, and also a half inch to a mile map of each county. The survey of the eastern counties is to be commenced; the survey of Derbyshire, Staffordshire, Shropshire, and Oxfordshire are to be continued, and progress is expected to be made with the survey of Hertfordshire, Buckinghamshire, Gloucestershire, Monmouthshire, and Cornwall during the year.

PROFESSOR TYNDALL ON SOUND-PRODUCERS (*continued*).—Most, if not all, of our ordinary sound-producers send forth waves which are not of uniform intensity throughout. A trumpet is loudest in the direction of its axis. The same is true of a gun. A bell, with its mouth pointed upwards or downwards, sends forth waves far denser in the horizontal plane passing through the bell than at angular distance of 90° from that plane. The oldest bellhangers must have been aware of the fact that the sides of the bell, and not its mouth, emitted the strongest sound, their practice being determined by this knowledge. Our slabs of gun-cotton also emit waves of different densities in different parts. It has occurred in the experiments at Shoeburyness that when the broad side of a slab was turned towards the suspending wire of a second slab six feet distant, the wire was cut by the explosion, while when the edge of the slab was turned to the wire this never occurred.

Theoretic considerations render it probable that the shape of the exploding mass would affect the constitution of the wave of sound. I did not think large rectangular slabs the most favourable shape, and, accordingly, proposed cutting a large slab into fragments of different sizes, and pitting them against each other. The differences between the sounds were by no means so great as the differences in the quantities of explosive material might lead one to expect. The mean values of eighteen series of observations made on board the "Galatea," at distances varying from 1½ miles, were as follows:—

Weights	4-oz.	6-oz.	9-oz.	12-oz.	7-oz. Rocket.
Value of sound..	3·12	3·34	4·0	4·03	3·35

These charges were cut from a slab of dry guncotton about 1⅝ inches thick: they were squares and rectangles of the following dimensions:—4 oz., 2 inches by 2 inches; 6 oz., 2 inches by 3 inches; 9 oz., 3 inches by 3 inches; 12 oz., 2 inches by 6 inches.

The numbers under the respective weights express the recorded value of the sounds. They must be simply taken as a ready means of expressing the approximate relative intensity of the sounds as estimated by the ear. When we find a 9 oz. charge marked 4, and a 12 oz. charge marked 4·03, the two sounds may be regarded as practically equal in intensity, thus proving that an addition of 30 per cent. in the larger charges produces no sensible difference in the sound. Were the sounds estimated by some physical means, instead of by the ear, the values of the sounds would not, in my opinion, show a greater advance with the increase of material than that indicated by the foregoing numbers. Subsequent experiments rendered still more certain the effectiveness, as well as the economy, of the smaller charges of gun-cotton.

It is an obvious corollary from the foregoing experiments that on our "nesses" and promontories, where the land is clasped on both sides for a considerable distance by the sea—where, therefore, the sound has to propagate itself rearward as well as forward—the use of the parabolic gun, or of the parabolic reflector might be a disadvantage rather than an advantage. Here guncotton, exploded in the open, forms the most appropriate source of sound. This remark is especially applicable to such lightships as are intended to spread the sound all round them as from central foci. As a signal in rock lighthouses, where neither syren, steam-whistle, nor gun could be mounted, and as a handy fleet-signal, which dispenses with the lumber of special signal-guns, the gun-cotton will prove invaluable. But in most of these cases we have the drawback that local damage may be done by the explosion. The lantern of the rock-lighthouse might suffer from concussion near at hand, and though mechanical arrangements might be devised, both in the case of the lighthouse and of the ship's deck, to place the firing-point of the gun-cotton at a safe distance, no such arrangement could compete, a regards simplicity and effectiveness, with the expedient of a *gun-cotton rocket*. Had such a means of signalling existed at the Bishop's Rock Lighthouse the ill-fated Schiller might have been warned of her approach ten, or it may be twenty, miles before she reached the rock which wrecked her. Had the fleet possessed such a signal, instead of the ubiquitous but ineffectual whistle, the *Iron Duke* and *Vanguard* need never have come into collision.

It was the necessity of providing a suitable signal for rock lighthouses, and of clearing obstacles which cast an acoustic shadow, that suggested the idea of the gun-cotton rocket to Sir Richard Collinson, Deputy Master of the Trinity House. That idea was to place a disc or short cylinder of the gun-cotton, which had proved so effectual at low levels, in the head of a rocket, the ascensional force of which should be employed to carry the gun-cotton to an elevation of 1,000 feet or thereabouts, where, by the ignition of a fusee associated with a detonator, the gun-cotton should be fired, sending its sound in all directions vertically and obliquely down upon earth and sea. The first attempt to realize this idea was made on 18th of July, 1876, at the fire-work manufactory of the Messrs. Brock, at Nunhead. Eight rockets were then fired, four being charged with 5 oz. and four with 7½ oz. of gun-cotton. They ascended to a great height, and exploded with a very loud report in the air. On the 27th of July, the rockets were tried at Shoeburyness. The most noteworthy result on this occasion was the hearing of the

rockets at the Mouse Lighthouse, 8½ miles E. by S., and at the Chapman Lighthouse, 8½ miles W. by N.; that is to say, at opposite sides of the firing-point. The performance of the rockets could not, in this case, be referred to the action of a favourable wind. It is worthy of remark that, in the case of the Chapman Lighthouse, land and trees intervened between the firing-point and the place of observation, "This," as General Younghusband justly remarked at the time, "may prove to be a valuable consideration if it should be found necessary to place a signal station in a position whence the sea could not be freely observed." Indeed, the clearing of such obstacles was one of the objects which the inventor of the rocket had in view.

In December, 1876, Mr. Gardiner, the managing director of the Cotton-powder Company, had proposed a trial of his material against the gun-cotton. The density of the cotton he urged was only 1·03. While that of the powder was 1·70. A greater quantity of explosive material being thus compressed into the same volume, Mr. Gardiner contended that a greater sonorous effect must be produced by the powder. A Committee of the Elder Brethren accordingly visited the cotton-powder manufactory, on the banks of the Swale, near Faversham, on the 16th June, 1877. The weights of cotton-powder employed were 2 oz., 8 oz., 1 lb., and 2 lbs., in the form of rockets and of signals fired a few feet above the ground. The experiments were arranged and conducted by Mr. Mackie.

The cotton-powder yielded a very effective report. The rockets in general had a slight advantage over the same quantities of material fired near the ground. The loudness of the sound was by no means proportional to the quantity of the material exploded, 8 oz. yielding very nearly as loud a report as 1 lb. The "aerial echoes," which invariably followed the explosion of the rockets, were loud and long continued, shading off, as in all previous cases, by imperceptible gradations into silence. From subsequent experiments it appeared that the gun-cotton and cotton-powder were practically equal as sound producers.

The performance of the syren was, on the whole, less satisfactory than that of the rocket. The instrument was worked, not by steam of 70 lb. pressure, as at the South Foreland, but by compressed air, beginning with 40 lbs. and ending with 30 lb. pressure. The trumpet was pointed to windward, and in the axis of the instrument the sound was about as effective as that of the 8 oz. rocket. But in a direction at right angles to the axis, and still more in the rear of this direction, the syren fell very sensibly behind even the 2 oz. rocket.

The explosion of substances in the air, after being carried to a considerable elevation by rockets, is a familiar performance. In 1873, moreover, the Board of Trade proposed a light-and-sound rocket as a signal of distress, which proposal was subsequently realised, but in a form too elaborate and expensive for practical use. The idea of the gun-cotton rocket with a view to signalling in fogs is, I believe, wholly due to the Deputy Master of the Trinity House. Thanks to the skilful aid given by the authorities of Woolwich, by Mr. Prentice, and Mr. Brock, that idea is now an accomplished fact; a signal of great power, handiness, and economy, being thus placed at the services of our mariners. Not only may the rocket be applied in association with lighthouses and lightships, but in the Navy also it may be turned to important account. Soon after the loss of the *Vanguard*, I ventured to urge upon an eminent naval officer the desirability of having an organised code of fog-signals for the fleet. He shook his head doubtingly, and referred to the difficulty of finding room for signal-guns. The gun-cotton rocket completely surmounts this difficulty. It is manipulated with ease and rapidity, while its discharges may be so grouped and combined as to give a most important extension to the voice of the admiral in command. It is needless to add that at any point upon our coasts, or upon any other coast, where its establishment might be desirable, a fog-signal station might be extemporised without difficulty.

[*To be continued.*]

IRRUPTION OF MOUNT HECLA.—On February 27th, at 5 p.m., several smart shocks of earthquake were felt at Reykjavik, and on the same evening flames were seen rising from behind the mountains in the direction of Hecla. The Rev. Gudmond Jonsson, who lives close to Hecla, reports that at 4.30 p.m. on that day, slight earthquake shocks could be felt. These gathered force during the next hour; until at 5 p.m. two severe shocks, which caused more alarm than real damage, terminated the disturbance. At 8 p.m. a tremendous irruption of flames burst out on the northern side of the volcano, increasing in magnitude till they appeared like gigantic columns, twice the height of the mountain. When the mail left Iceland, on March 22nd, the irruption still continued, but apparently with diminished violence.

City Notes.

Old Broad Street, April 20th, 1878.

THE meeting of the West India and Panama Telegraph Company is held a day too late for us to notice in this issue; but the report is an extremely interesting document—we can imagine what a glaring circular will emanate immediately from Tokenhouse Yard. Nor, it must be admitted, will the author be without considerable justification for sounding the trumpet loudly. We gather in the first place that the total receipts of the company for the year amounted to £77,975 against £63,548 the preceding year, and £24,000 represnts a sum of money worth mentioning. In the second place, while the amount to audit of revenue for the last year has been no less than £37,065, the expenses have been

but £20,139, and there, consequently, remains a balance of £16,925. Adding to this a balance of £905, brought forward from last half-year's account, we find a total of £17,830 available for the directors to deal with at their pleasure. The directors propose to deal with it thus:—they will add, very properly, £1,000 to reserve (a larger sum would have been better, but we must hope for better things this time next year); then they devote £10,369 to the payment of 6 per cent. dividend on the first Preference Shares, and £1,400 to the payment of 6 per cent. dividend on the second Preference issue. Of the remaining sum they will devote £4,416 to the payment of 1 per cent. dividend on Ordinary Shares, and carry forward to the next account £644. Having explained that the half-year from June to December is the least active period of business in the West Indies, the directors direct attention to the circumstance that the receipts from traffic for the half-year show an increase of £4,135, over those of the corresponding period of 1876, due to the augmentive traffic, and it is likewise declared that this increase would have amounted to about £6,300, but for the diminution of revenue occasioned by the interruption of the Para-Demerara Cable and the consequent loss of North and South American business. The interrupted cable will, it is expected, be in working order shortly. At the conclusion of the report we observe that the affairs of the old company are once more brought into prominence, and, accompanying the ordinary statement of accounts, is a statement of the account of the liquidators—liquidating Act £551, or liquidating and re-constructing £722. The debit side of the half-yearly revenue account is noticeable chiefly for an item of £7,847, costs of repairs to cables, while as to the balance sheet it may be mentioned that to the creditors of the company £8,591 is due. On the other hand, £10,411 is owing to the company from sundry debtors. £124 is a small account for bills payable, and £11,948 a considerable one for bills receivable. It is satisfactory to be assured that the liquidation of the old company is at length practically effected, and though we may not quite endorse the averment that the value of West Indian and Panama shares has been increased in the aggregate by 40 per cent. since the adoption of the re-construction scheme, things are looking up decidedly.

In the report of the Submarine Cables Trust for the year ending April 15, it is stated that the revenue of the Trust has suffered very considerably during the year from the competition which took place between the Anglo-American and the Direct United States Companies; which shows that there is, after all, people in the world who have some reason to rejoice at the amalgamation of the companies; does it not? The revenue of the Trust for the year amounted to £24,750 and the expenses to £1,303, leaving a balance of £23,447. It is notified that of this sum £20,844 has been applied to the payment of the coupons due on the 15th October, 1877, and the 15th of April, 1878, and the balance of £2,603 is carried forward. There is nothing in the report or accounts which calls for special remark.

There is much that is encouraging in the neat little report of the Annual General Meeting of the Great Northern Telegraph Company of Copenhagen. Respecting the state of the cables during 1877, there was one interruption—between Denmark and France; but that cable has since been restored, and nothing detrimental has happened to any of the others. The working of the lines has also been extremely satisfactory. Instead of instruments formerly used, the invention of Mr. Lauritzen—a gentleman belonging to the staff of the company—has been adopted with complete success. Mr. Lauritzen is to be congratulated. As to the traffic years, the directors of the company thought that 1874 was a capital year, but 1877 was better, the revenue of the latter exceeding that of the former by 46,634 francs. The number of telegrams transmitted was 739,146. Nor do we find on turning to the report of the cables in China and Japan, any ground for complaint. The cables have been interrupted but only for 35 days during the year; in 1876 they were interrupted for 50, and in 1875, for 89 days. Every one interested in the progress of the science of telegraphy, will be glad to notice this improvement. It is also gratifying to learn that the repairs have, in all cases, been successfully completed by the company's steamer and staff; and no small degree of credit is due to the company for the perseverance its officers have shown in assisting in the inspection of the land lines in Eastern Russia. Before long we hope the company may be able to make some progress with regard to the land lines in China. The final dividend of 2s. 9d. is now payable at Messrs. Hambro's Bank, Old Broad Street.

A new cable law of very considerable importance has been reported favourably to the American Congress. The bill was prepared by Mr. Monroe, of Ohio, and is intended to deal with the applications which are, as we know, from time to time made to the United States Government for permission to land submarine telegraph cables on the American coast. We have not space to spare for the "auditories, stipulations, and reservations," which Mr. Monroe has incorporated in the bill, but they will probably be keenly criticised here. It is quite clear that our friends on the other side of the Atlantic intend, henceforth, to reap any benefits which it may be possible for them to do in return for any concessions they may grant. Nor can we blame them. A general law for the landing of cables will, we think, be a move in the right direction. The provisions of the measure which is now before Congress do not seem to us to be unfair. We imagine, however, that if Congress accepts the substance of them, the "sole right" of landing on the coast of the United States will then, at any rate, be vested in no particular body of shareholders.

We observe that another American journal, the New York *Operator*, referring to a step recently taken by the Western Union Company, says:—"The Western Union reducing salaries under pretext of grading! You must be mistaken. Did not that company's official organ distinctly say that under a single management the telegraphs of the company could be much more economically conducted, thus leaving a larger margin for profits, and that the salaries of operators would be 'apportioned accordingly'? And did not the company assure its employés that it 'would not forget their honourable and manly conduct' on the occasion of the strike of 1870? Surely, no individual possessed of a spark of honour could take so contemptible a means of reducing the salaries of faithful employés after such promises."

An important extension of the Midland Railway Company which cannot fail to be beneficial alike to the shareholders of that company and to those of the Metropolitan District, will come into operation to-morrow. This new service of trains will be from Child's Hill, on the main Midland line, to Earl's Court on the District, *viâ* Acton and Hammersmith, and passengers will be conveyed by the Midland Company's own trains from all parts of their system to stations up to Earl's Court, thus establishing direct communication between the Mansion House and Child's Hill. There are, we understand, to be, if necessary, twenty trains each way per day. We believe that before long the trains of the Brighton and South Coast Company will also run over the District lines.

THE TELEGRAPHIC JOURNAL.
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AN OVERLAND LINE TO THE CAPE.

In our March number we had to consider the question of cable communication between the Cape Colonies of South Africa and Europe, and the respective schemes of Mr. Donald Currie and Sir James Anderson for attaining this end. We have now to review another, and a more striking proposal to the same effect, which emanates from Cape Colony itself. On March 27th last, Mr. Sivewright, the Superintendent of Telegraphs for the Colony, delivered a very interesting lecture on this subject to the members of the Philosophical Society of Cape Town, and unfolded an original scheme, at once practical and daring, for connecting South Africa telegraphically to Europe, not by means of submarine cables, either along the East or West Coast of Africa, but by a land-line running through the heart of the continent. It is conceded on all sides that a telegraph to Europe would greatly benefit the South African Colonies; and the state of feeling with regard to it in these colonies is such as is likely to bring it about before long. The question which will have first to be settled is whether it should be a land-line or a cable. Mr. Sivewright argues against a cable that experience has shown cables to be very short-lived, and altogether insecure property; that a cable from Aden to Natal *viâ* Mauritius would cost, at least, £1,000,000; and that a repairing ship would require to be kept up at an annual cost of £10,000 to £12,000. To raise this vast sum, and maintain the line, would saddle the company with a yearly tax of something like £80,000, and as only £40,000 of this might be expected from the traffic, there would remain a balance of £40,000 to be made up by subsidies from Cape Colony, Natal, and Mauritius. At the present time the Egyptian lines extend to Khartoum in Nubia, at the junction of the Blue and White Niles, and, in a comparatively short time, they will reach as far as Gondokoro, on the White Nile, some two hundred miles below its rise in the Albert Nyanza, lat. 4°. 54′ N. The colonial lines now run as far north as Kimberley and Pretoria, the capital of the Transvaal. From either of these places the distance to Gondokoro, as the crow flies, is 2,000 miles; but a direct route through the centre of the continent, by way of the great lakes, with spur lines to Mozambique, Zanzibar, and other places, is wisely discarded by Mr. Sivewright. His plan is to connect Kimberley or Pretoria to Gondokoro, by a single line wire 2,500 miles long, in three great divisions from Kimberley to Tete, a trading town, up the Zambesi, from Tete to Zanzibar on the coast, and from Zanzibar to Gondokoro. The first division would take in the capitals of several friendly native chiefs, and would pass through well-known territory. The second would take in the mission town called Livingstonia, on Lake Nyassa, and would then follow the route traversed by Livingstone, in his earlier journeys, to near Cape Delgado, and thence to Zanzibar, over country which Dr. Kirk considers both safe and easy. The last division appears likely to prove the most difficult, since it would have to pass through an unexplored region, peopled by unfriendly natives. With Kimberley, Tete, Zanzibar, and Gondokoro as basis of operation, the range of transport for each section need not exceed 400 miles, whereas in constructing the Australian overland line, everything required had to be carried in waggons as much as 1,200 miles. Another point in favour of the scheme is that it includes Zanzibar, an important port of trade in the main route.

A subsequent cable from Aden to Zanzibar would not be a very great undertaking, and it would be an additional security as an alternate line of communication. As regards the construction of the line, Mr. Sivewright naturally does not anticipate any insurmountable difficulties. Bullocks would be employed for transport in regions free from *tsetse* fly, and camels or natives in infested places; indigenous woods would be employed for poles, and where suitable woods failed, iron poles would be used. There would be stations of maintenance every two hundred miles apart, so that breakdowns could speedily be put right. We incline to agree with Mr. Sivewright that the difficulties and dangers likely to arise from marauding monkeys, elephants, and hostile natives, are not of a very deterrent nature, and would probably prove less formidable in reality than might be imagined beforehand. The Prairie Indians have a superstitious reverence for the telegraph, which we must all admit to be very well bestowed, and highly creditable to them as a race. The nomadic Arabs along the Euphrates section of the Indo-European line were brought to look with favour on the wire through the magic of a yearly "backsheesh" to their chiefs; and if the Negro did not constitute the line a fetish of more than ordinary malevolence, he might be brought at least to regard it as a mysterious source of revenue. We do not doubt that the difficulties of construction and maintenance could be successfully overcome as similar difficulties have been overcome before on the Indio-European, the Rocky Mountain, the Trans-Andine, and the Australian lines; but we

have misgivings about Mr. Sivewright's estimate of the total cost. He considers £200 a mile on an average "more than ample to cover all the expenses in connection with the work." For the 2,500 miles this gives a total cost of £500,000, or half the cost of cable. According to the *Cape Argus*, from which we have drawn the details of the scheme, the yearly tax on the company for interest on capital and maintenance would be about £50,000, and taking £25,000 as the proceeds of the traffic, there would be a balance of £25,000 to be raised by subsidies from Cape Colony, Natal, and perhaps the Sultan of Zanzibar and the Imperial Government. If these figures are correct, we think that Mr. Sivewright has made out a good case for his project; but it appears to us that running a line through the dense jungle of the central portions of the continent, where the road has to be made first, and a wide track cleared of bush to keep the trees from encroaching on the line, would swallow up more than £200 per mile. Mr. H. M. Stanley has, we are told, expressed himself strongly against the scheme, characterising it as visionary and impracticable; whereas Col. Grant, on the other hand, has recommended it. Before deciding, therefore, in favour of a land-line, it will be wise to get a more thorough acquaintance with the proposed route; and it would be well if the competing sea routes were sounded also, for experience in cable work has shown that we are too apt to take it for granted that all is smooth and still at the bottom of the sea.

IMPROVEMENTS IN QUADRUPLEX TELEGRAPH APPARATUS.

THE following is a description of an improvement in quadruplex apparatus, made by Mr. Gerritt Smith, and, with the diagram, will give a very clear idea of its operation. It is now in successful use on the lines of the Western Union Telegraph Company, and has been found in practice to work satisfactorily on the longest circuits.

A general plan of the apparatus, including both the transmitting and receiving instruments, is shown in the diagram.

The transmitting devices, both in construction and mode of operation, are similar to those employed in the earlier form of apparatus; consequently, it is only necessary to allude herein to the effect produced upon the line by the operation of two independent transmitters, or keys, when thus arranged, which is as follows:

First.—Key K_1 and K_2 both open. In this position the entire battery is in circuit, sending to the line a negative or — current of $-B - 3B = -4B$.

Second.—Key K_1 open and K_2 closed. In this case battery B only is in circuit, sending to the line a negative or — current of $-B$.

Third.—Key K_1 closed and K_2 open. The entire battery is again in circuit, but in this case with the positive or + pole to the line, sending a current of $+3B+B = +4B$.

Fourth.—Key K_1 and K_2 both closed. In this position the battery B only is in circuit, sending to the line a positive or + current of $+B$.

Thus it will be understood that the line is caused to assume four distinct electrical conditions, corresponding with the four possible positions of the keys at the transmitting station.

The receiving apparatus consists of two sounders, S_1 and S_2, which are controlled by relays R_1 and R_2. The construction and mode of operation of the former is the same in every particular as that now in use on the numerous lines of the Western Union Telegraph Company on which the quadruplex system is worked, designated as relay No. 1, and is fully described* in Mr. Prescott's work, *Electricity and the Electric Telegraph.*

The relay R_2 differs materially, however, from the relay R_1 in the arrangement of its local circuit connections, by means of which the sounder S_2 is operated; and the improvement upon the form of relay heretofore used consists chiefly in dispensing with one of the supplementary contact levers, whereby the apparatus is not only simplified, but made to work with greater facility and certainty through long circuits.

The normal position of the apparatus when neither key at the transmitting station is depressed, is that shown in the diagram.

The manner in which the relays R_1 and R_2 operate in each of the four electrical conditions of the line mentioned, so as to cause the sounder S_1 to respond solely to the movements of key K_1, and the sounder S_2 in like manner to the movements of key K_2, and both in response to a simultaneous depression of keys K_1 and K_2, will be understood by reference to the following explanation:

First.—K_1 and K_2 both open. A negative or — current from both batteries ($-4B$). The local circuit of sounder S_1 is kept open, because the polarity of the line current tends to hold the armature h of relay R_1 on its back stop p. The local circuit of sounder S_2 is also open between armature j and lever r, because the current on the line is sufficiently powerful to overcome the spring r_1 and hold armature j against stop o; thus sounder S^2 remains inactive.

Second.—K_1 open and K_2 closed, a negative or — current from battery B only ($-B$). The local circuit of sounder S_1 remains open between stop p_1 and armature h, because the polarity of the current is such as to hold the latter against stop p. The action of this current upon relay R, is to cause its armature J, assisted by spring R_1 to move to the left and make contact with the lever r, but not with sufficient force to overcome the retractile spring q_1, thus leaving armature J in a central position between stops o and o_1, thereby closing the local circuit and operating sounder S .

Third.—K_1 closed and K_2 open, a positive or + current from both batteries ($+4B$). This current causes the armature h of relay R_1 to move to the left, thus closing the local circuit at stop p_1 and actuating sounder S . The armature J of relay R_2 is also strongly attracted towards the left, pressing against the yielding lever r with sufficient force

* See TELEGRAPHIC JOURNAL, Jan. 1, 1876.

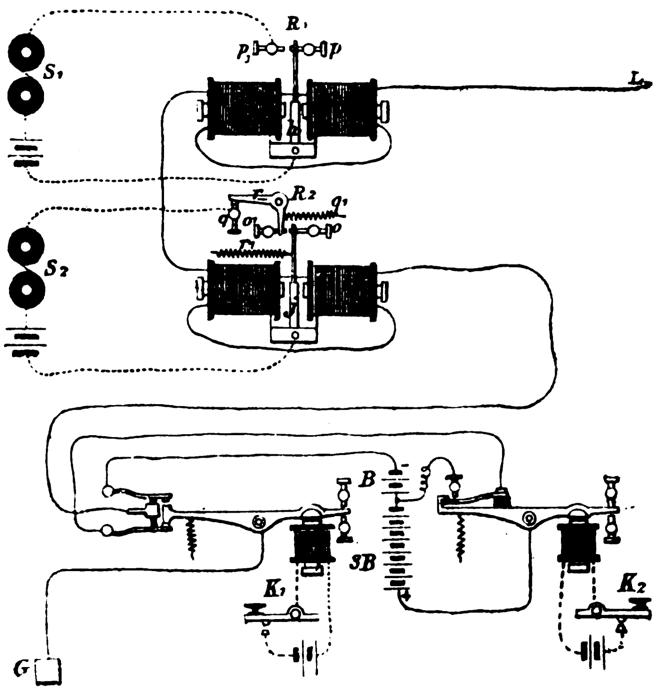
to overcome the spring q_1, and press the former against the stop o_1, thus opening the local circuit of sounder S_2.

Fourth.—Keys K_1 and K_2 both closed, positive or + current from battery B only (+ B). Relay R_1, which is arranged to close its local circuit by positive currents of any strength, actuates the sounder S_1 precisely as in the third case. The current upon the line in this case is not of sufficient strength to hold the armature J of relay R_2 against stop o_1, consequently it moves, together with lever *r*, assisted by spring q_1, to a central position, thus closing the local circuit between armature J and stop *q* through lever *r*, thereby operating sounder S_2. When the armature J of relay R_2 passes directly over from one extreme position to the other, for example, from stop *o* to o_1, it will be observed that the local circuit is closed for an instant, but not long enough to produce any effect whatever upon the lever of sounder S_2.

It is therefore obvious that, with the apparatus arranged as herein illustrated and described, two communications may be simultaneously transmitted over a single conductor, and the signals recorded with facility and accuracy.

In order that four communications may be made to pass simultaneously over a single conductor, it is only necessary to combine the apparatus herein described with any suitable one of the several known methods of simultaneous transmission in *opposite* directions. The arrangement in general use for the accomplishment of this purpose upon the Western Union Telegraph Company's lines, is known as the differential method. A system of duplex telegraphy, known as the bridge method, may be used instead of the differential, or, instead of either of these, a combination of the differential and bridge methods. In practice the latter has been found preferable, more especially on the longer circuits, where the signals have to be re-transmitted automatically over an adjoining circuit, in which case it is absolutely essential that the signals should be recorded perfectly at the repeater station.

The last-named plan is in operation on the New York and Chicago quadruplex circuit, arranged so that signals from New York and Chicago are at Buffalo automatically re-transmitted in either direction.—*Journal of the Telegraph.*



A CLOSED CIRCUIT TRANSLATOR.

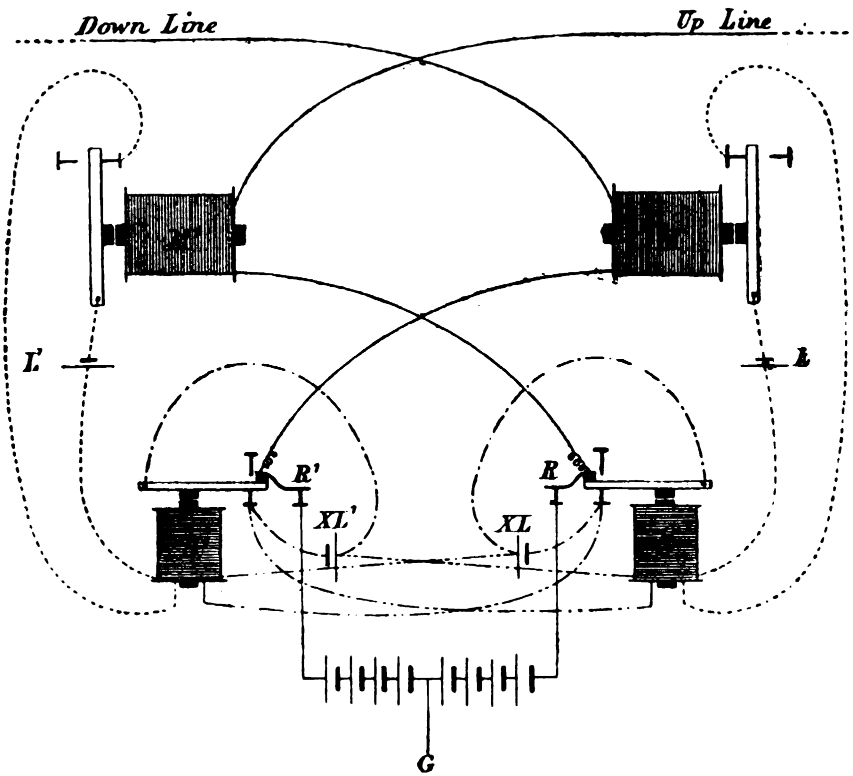
By S. M. BANKER.

THE difficulty with which we have to contend with in a closed circuit translator or repeater, consists in having to keep closed the repeating point belonging to, and forming a part of, the circuit of that side which is sending, and at the same time to keep it perfectly under the control of the other or receiving side.

In the Figure it will be seen that each side of the repeater consists of an electro-magnet M, M¹, and sounder S, S¹, only; and the distinctive feature of the arrangement is, that only the sounder is required

to undergo any change of construction from those in ordinary use, each sounder, S, S¹, having its coils double wound with the same size wire and of the same resistance for two separate circuits, and the armature lever having an insulated spring contact for making and breaking the line circuit.

Now, when an "up" station, for instance, wishes to break, it will be seen that the circuit passes through M¹ on to repeating point R of sounder S to the main battery, and so to earth: hence, on "up" breaking the circuit, the armature of M¹ falls off the local circuit contact by means of an antagonistic spring, and in consequence the armature lever of very small compared with the resistance through the coil; so we see that, when "up" breaks, the action of the sounder S¹ is first to break the local circuit X L¹, sending the current from X L¹ through the second coil of sounder S, and then to break the "down" circuit at repeating point R¹, thus keeping the armature lever of sounder S down, and the "up" circuit intact. Again, on "up" closing the circuit, the sounder S¹ will restore the "down" circuit at point R¹ before diverting local X L¹ from sounder S, and by this means forming the local circuit L through sounder S before the local battery X L¹ is diverted through armature lever of S¹. Now



S¹ rises off its lower stud, breaking the "down" circuit at the repeating point R¹; this last action causes the lever of M to break the local circuit L through the sounder S, and the rising of its armature lever would break the "up" circuit also at the point R but for the following device:—Each sounder is provided with a second local for the second circuit through its coils, and this second circuit can be diverted or cut off from the coil by means of the armature lever of the opposite sounder. Suppose that both sounders are closed, the lines being in their normal condition, the extra local batteries X L, X L¹ are on short circuit through levers of sounders; but when either sounder lever rises—the circuit through this route being broken—the current then passes through the coil of opposite sounder holding down the armature as a consequence of the resistance through the lever being suppose "down" wishes to stop "up" when he is sending: he merely breaks the circuit, and the first time "up" closes his circuit in sending, he finds it broken by the point R, the result of the "down" break.

The action of the repeating points in the above arrangement is to make the dots and dashes longer or firmer, by making contact before the sounders, and breaking later.

The electro-magnets M, M¹, may be double wound instead of the sounders, if thought preferable.

IT is stated in America that a company of English merchants have offered Mr. Edison £60,000 if he can successfully apply his aërophone or talking fog-horn to "the local telegraph wires" in London.

ON THE ACTION OF SONOROUS VIBRATIONS IN VARYING THE FORCE OF AN ELECTRIC CURRENT.*

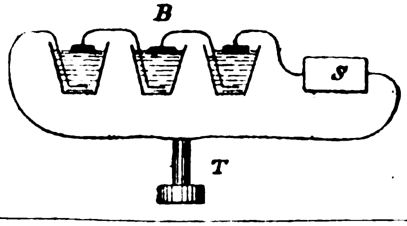
By Professor D. E. HUGHES.

THE introduction of the telephone has tended to develope our knowledge of acoustics with great rapidity. It offers to us an instrument of great delicacy for further research into the mysteries of acoustic phenomena. It detects the presence of currents of electricity that have hitherto only been suspected, and it shows variations in the strengths of currents which no other instrument has ever indicated.

It has led me to investigate the effect of sonorous vibrations upon the electrical behaviour of matter. Willoughby Smith has shown that the resistance of selenium is affected by light, and Börnstein has led us to believe that many other bodies are similarly affected. We know also that the resistance of all bodies is materially influenced by heat. Sir William Thomson and others have shown that the resistance to the passage of currents offered by wires is affected by their being placed under strains, and, inasmuch as the conveyance of sonorous vibrations induces rapid variations in the strains at different points of a wire, I believed that the wire would vary in its resistance when it was used to convey sound. To investigate this I made a rough-and-ready telephone, with a small bar magnet four inches long, half the coil of an ordinary electro-magnet, and a square piece of ferro-type iron, three inches square, clamped rigidly in front of one pole of the magnet between two pieces of board. When using the pendulum beats of a small French clock, or the voice, as a source of sound, I found this arrangement supplied me with an extremely delicate *phonoscope* or sound detector.

All the experiments detailed in this paper were made with the simplest possible means, and no apparatus of any kind constructed by a scientific instrument maker was employed. The battery was a simple Daniell's cell, of Minotto's form, made by using three common tumblers, a spiral piece of copper wire being placed at the bottom of each glass and covered with sulphate of copper, and the glass being then filled with well-moistened clay and water. A piece of zinc as the positive element was placed upon the clay. Iusulated wires were attached to each plate, and three of these cells were joined in series. All experiments were made on a closed circuit, the telephone being used as a phonoscope to detect variations in the current and the consequent reproduction of sound. The apparatus, or materials experimented upon, were used in the same way as the transmitter of the speaking telephone of Bell. The attached sketch will make this clear. B is the battery, S the source of sound or material examined, T the telephone or phonoscope.

Fig. 1.



I introduced into the circuit at S a strained conductor—a stretched wire—listening attentively with the telephone to detect any change that might occur when the wire was spoken to or set into transverse vibrations by being plucked aside. Gradually, till the wire broke, the strain was varied, but no effect whatever was remarked except at the moment when the wire broke. The effect was but momentary, but invariably at the moment of breaking a peculiar "rush" or sound was heard. I then sought to imitate the condition of the wire at the moment of rupture by replacing the broken ends and pressing them together with a constant and varying force by the application of weights. It was found that if the broken ends rested upon one another with a slight pressure of not more than one ounce to the square inch on the joints, sounds were distinctly reproduced although the effects were very imperfect.

It was soon found that it was not at all necessary to join two wires endwise together to reproduce sound, but that any portion of an electric conductor would do so even when fastened to a board or to a table, and no matter how complicated the structure upon this board, or the materials used as a conductor, provided one or more portions of the electrical conductor were separated and only brought into contact by a slight but constant pressure. Thus, if the ends of the wire terminate in two common nails laid side by side, and are separated from each other by a slight space, were electrically connected by laying a similar nail between them, sound could be reproduced. The effect was improved by building up the nails log-hut fashion, into a square configuration, using ten or twenty nails. A piece of steel watch chain acted well. Up to this point the sound or grosser vibrations were alone produced, the finer inflections were missing, or, in other words, the *timbre* of the voice was wanting, but in the following experiments the *timbre* became more and more perfect until it reached a perfection leaving nothing to be desired. I found that a metallic powder such as the white powder—a mixture of zinc and tin—sold in commerce as "white bronze," and fine metallic filings, introduced at the points of contact, greatly added to the perfection of the result.

At this point articulate speech became clearly and distinctly reproduced, together with its *timbre*, and I found that all that now remained was to discover the best material and form to give to this arrangement its maximum effect. Although I tried all forms of pressure and modes of contact, a lever, a spring; pressure in a glass tube sealed up while under the influence of strain, so as to maintain the pressure constant, all gave similar and invariable results, but the results varied with the materials used. All metals, however, could be made to produce identical results, provided the division of the metal was small enough, and that the material used does not oxidise by contact with the air filtering through the mass. Thus platinum and mercury are very excellent and unvarying in their results, whilst lead soon becomes of such high resistance, through oxidisation upon the surface, as to be of little or no use. A mass of bright round shot is peculiarly

* Communicated by Prof. Huxley to the Royal Society. Received May 8, 1878.

sensitive to sound whilst clean, but as the shot soon become coated with oxide this sensitiveness ceases. Carbon again, from its surface being entirely free from oxidation, is excellent, but the best results I have been able to obtain at present have been from mercury in a finely divided state. I took a comparatively porous non-conductor, such as the willow charcoal used by artists for sketching, heating it gradually to a white heat and then suddenly plunging it in mercury. The vacua in the pores, caused by the sudden cooling, become filled with innumerable minute globules of mercury, thus, as it were, holding the mercury in a fine state of division. I have also tried carbon treated in a similar manner with and without platinum deposited upon it from the chloride of platinum. I have also found similar effects from the willow charcoal heated in an iron vessel to a white heat, and containing a free portion of tin, zinc, or other easily vaporised metal. Under such conditions the willow carbon will be found to be metallized, having the metal distributed throughout its pores in a fine state of division. Iron also seems to enter the pores if heated to a white heat without being chemically combined with the carbon as in graphite, and, indeed, some of the best results have been obtained from willow charcoal containing iron in a fine state of division.

Pine charcoal treated in this manner (although a non-conductor as a simple charcoal) has high conductive powers, due to the iron; and from the minute division of the iron in the pores, is a most excellent material for the purpose.

Any one of these preparations confined in a glass tube or a box, and provided with wires for insertion in a circuit, I call a "transmitter."

Reis, in 1860, showed how, by the movement of a diaphragm, intermittent voltaic currents could be transmitted, agreeing in exact number with the sonorous waves impinging on the diaphragm, and thus reproducing music at a distance by causing an electro-magnet to vibrate in unison with the diaphragm; and, with an iron diaphragm, Graham Bell showed how the vibrations of that diaphragm in front of a polarized electro-magnet could similarly induce magneto-currents, corresponding in number, amplitude, and form, with the sonorous vibration, and thus reproduce all the delicacies of the human voice. Edison and others have produced variations in the strengths of a constant current by causing the diaphragm to press directly upon some elastic conductor, such as carbon, spongy platinum, &c., the varying pressure upon these materials varying the resistance of the circuit, and consequently the strength of current flowing. Graham Bell and others have produced the same effect, by causing the vibrations of the diaphragm to vary the electro-motive force in the circuit. It will be seen, however, that in the experiments made by myself, the diaphragm has been altogether discarded, resting as it does upon the changes produced by molecular action, and that the variations in the strengths of the currents flowing are produced simply and solely by the direct effect of the sonorous vibrations.

I have found that any sound, however feeble, produces vibrations which can be taken up by the matter interposed in the electrical circuit. Sounds absolutely inaudible to the human ear affect the resistance of the conductors described above. In practice, the effect is so sensitive, that a slight touch on the board, by the finger nail, on which the transmitter is placed, or a mere touch with the soft part of a feather, would be distinctly heard at the receiving station. The movement of the softest camel hair brush on any part of the board is distinctly audible. If held in the hand, several feet from a piano, the whole chords—the highest as well as the lowest—can be distinctly heard at a distance. If one person sings a song, the distant station, provided with a similar transmitter, can sing and speak at the same time, and the sounds will be received loud enough for the person singing to follow the second speech or song sent from the distant end.

Acting on these facts, I have also devised an instrument suitable for magnifying weak sounds, which I call a *microphone*. The microphone, in its present form, consists simply of a lozenge-shaped piece of gas carbon, one inch long, quarter inch wide at its centre, and one-eighth of an inch in thickness. The lower pointed end rests as a pivot upon a small block of similar carbon; the upper end, being made round, plays free in a hole in a small carbon-block, similar to that at the lower end. The lozenge stands vertically upon its lower support. The whole of the gas carbon is tempered in mercury, in the way previously described, though this is not absolutely necessary. The form of the lozenge-shaped carbon is not of importance, provided the weight of this upright contact piece is only just sufficient to make a feeble contact by its own weight. Carbon is used in preference to any other material, as its surface does not oxidise. A platinum surface in a finely-divided state is equal, if not superior, to the mercurised carbon, but more difficult and costly to construct. I have also made very sensitive ones entirely of iron.

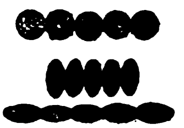
The best form and materials for this instrument, however, have not yet been fully experimented on. Still, in its present shape, it is capable of detecting very faint sounds made in its presence. If a pin, for instance, be laid upon or taken off a table, a distinct sound is emitted, or, if a fly be confined under a table-glass, we can hear the fly walking, with a peculiar tramp of its own. The beating of a pulse, the tick of a watch, the tramp of a fly, can thus be heard at least a hundred miles distant from the source of sound. In fact, when further developed by study, we may fairly look for it to do for us, with regard to faint sounds, what the microscope does with matter too small for human vision.

It is quite evident that these effects are due to a difference of pressure at the different points of contact, and that they are dependent for the perfection of action upon the number of these points of contact. Moreover, they are not dependent upon any apparent difference in the bodies in contact, but the same body in a state of minute subdivision is equally effective. Electrical resistance is a function of the mass of the conductor, but sonorous conduction is a function of the molecules of matter. How is it therefore that a sonorous wave can so affect the mass of a conductor as to influence its electrical resistance? If we assume a line of molecules, we know that a sonorous wave is accompanied by alternate compressions and rarefactions. If we isolate the part under compression from the part under dilation we vary the dimensions of the mass, and we alter its electrical resistance. In any homogenous conductor of finite dimensions the effect of

the one will exactly compensate for the effect of the other, and we get no variation of current; but if we break up this homogeneous conductor into a series of minute subdivisions without actually breaking their electrical continuity we destroy this neutralising influence, and we render evident the effect of sonorous vibrations in varying the dimensions of the mass of the conductor, and therefore in varying its electrical resistance, for we reduce the length of a portion of the conductor to a fraction of the length of a sonorous wave. Molecular action alone explains to me all the effects produced. Size or shape does not affect them. A piece of willow charcoal, the size of a pin's head, is quite sufficient to reproduce articulate speech. I regard the action as follows:—If we have two separate conductors joined simply by contact this contact offers a certain resistance. Now we can vary or lessen the resistance by increasing the pressure, thus bringing more points in contact or closer proximity. Now, as I employ a constant pressure on the contact, which is exactly under the same influence of the vibrations as the points of contact, more points or closer proximity can only be obtained through the molecular swelling or movement of the contact points.

If we assume a line of molecules at the point of contact of the minute masses of conducting matter in their neutral condition to be arranged thus:—

Fig. 3.

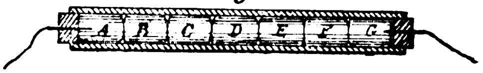


they will appear under compression as in second line of fig. 3, and under dilatation, as in third line of fig. 3.

In the former case the electrical resistance would be *less*, and in the latter case *more* than in the normal condition. Hence we should get variation in their electrical resistance, and thus sonorous waves could vary the strength of an electric current, and the variations of the electric current can be made to reproduce sonorous vibrations. These, however, would only produce the result in a certain line, say horizontal; but those perpendicular, while producing the same result, would be a half vibration behind, and thus if two contacts, the one horizontal and the other perpendicular, were on the same piece of charcoal and the conducting line joined to both, we should have interference. The contrary takes place as the more contacts we have, and the more varied their direction on the same the louder and purer the sound becomes. Hence there is no interference, and consequently the whole mass must swell and diminish equally in all directions at the same instant of time.

The tube transmitter, which I exhibit this evening, consists of an exterior glass tube two inches long and one quarter of an inch in diameter. In it are separate pieces of willow charcoal, each one quarter of an inch long and two terminals of the same material. The terminals are fastened in the tube, and connect exteriorly with the line and interiorly with the four loose pieces, thus:—

Fig. 2.



Here A is made to press on B, C, D, E, F, and G, until the resistance offered to the electrical current is about one-third that of the line upon which it is to be employed. It may be attached to a resonant board by the ends A or G. If the result was simply due to vibrations, we should have A and B making greater contact at a different time from F and G, and consequent interference. If it was a simple shaking or moving of B, C, D, E, and F, it could produce no change, as if B pressed more strongly on C, it would be less on A, and also if the tube was attached by the centre we should have no effect; but if the effect is due to a swelling or enlargement of B, C, D, E, F, it would make no difference where it is attached to the resonant board, as is actually the case. Again reduce the pressure of A upon B, &c., until they are not in contact, and no trace of current can be perceived by shaking the tube. The instant the sonorous vibrations pass in the tube there is electric contact to a remarkable degree, which could only have taken place by the molecules enlarging their sphere under the influence of the sonorous vibrations.

It is impossible to say what can be the applications or the effects of the discovery which I have had the honour of bringing before the Royal Society, for the whole question has been studied with crude materials, and scarcely sufficient time has elapsed to enable me to consider its ultimate uses. I do not desire to assert that there is anything in what I have brought forward that is superior to or equal to other transmitters used for telephony. It is as loud and far more sensitive than any I have yet heard, and it may be increased by multiplication of transmitting contacts in quantity or intensity; the loudness is at present limited by the capability of the receiver. The materials at my disposal, and the arrangement of them, have not yet been sufficiently studied. I only wished to show that it is possible to transmit clear and intelligent articulate speech, and to render audible sounds which have hitherto been inaudible by the mere operation of sonorous vibrations upon the conducting power of matter.

My warmest thanks are due to Mr. W. H. Preece, electrician to the Post Office, for his appreciation of the importance of the facts I have stated, and for his kind counsel and aid in the preparation of this paper.

I do not intend to take out a patent, as the facts I have mentioned belong more to the domain of discovery than invention. No doubt inventors will ere long improve on the form and materials employed. I have already my reward in being allowed to submit my researches to the Royal Society.

THE German Patent Office received 6,424 applications for patents during the past year, a greater number than was applied for in any other country except the United States.

ON THE PHOTOMETRY OF THE MAGNETO ELECTRIC LIGHT.

By Captain W. de W. ABNEY, R.E., F.R.S.

At intervals during the last three years it has been my duty to ascertain the value of the illuminating power of different sources of light, which have been brought before Government for military purposes. As there is nothing secret in the results obtained, it seemed to me that I might communicate them to the Royal Society, and I have obtained permission so to do.

The primary object of the experiments was to ascertain the relation between the horse-power expended, the light produced, and the number of revolutions of the armature. The machine employed was of the Gramme form, and weighed somewhere about 17 cwt. It had three pairs of vertical coils, one of which was used for magnetisation. To work it, what is known as the steam sapper was employed. This is a road locomotive from the shops of Aveling and Porter, of Rochester, and is adapted to driving machinery by applying a band to the fly-wheel. It works fairly steadily when not overtaxed. An indicator was attached for taking diagrams from which to calculate the horse-power expended. The number of revolutions of the armature was taken by a velocimeter, and a large tangent galvanometer was inserted in the circuit, the diameter of the arc being 33 times that of the needle. An automatically working electric lamp having perfectly dry square carbons of ½ inch side was the source of light, and was placed at fixed distances of 75, 150, or 50 feet from the measuring apparatus as circumstances required. It gave a steady light when the engine worked regularly, and the brilliancy of the light was not increased by altering the distance apart of the carbons. When a series of readings was to be taken, the horse-power expended in driving the machine with the collecting brushes up was found, and then the brushes turned down, and the light allowed to burn for ten minutes before any measurement was taken. The number of revolutions of the armature was then approximately ascertained, and a diagram taken when the velocimeter was applied to the machine. The readings of the galvanometer were recorded by an assistant working under my colleague, Captain Armstrong, R.E., and the measurements of the illuminating power taken by myself and checked by an intelligent assistant.

To secure the separation of the different portions of the spectrum, resort was had to absorbing media. After many trials I came to the conclusion that nothing seemed preferable to red glass, which absorbed practically every part of the spectrum except the red end, and an ammoniacal solution of copper sulphate. These two absorbing media were employed in the experiments; very little of spectrum is left unaccounted for, and the results obtained are sufficiently striking to record.

A red glass was obtained which had sufficiently plane surfaces, and a cell with parallel sides was used for holding the copper solution. The absorbing media were placed between the rod and the opaque screen, and absolutely parallel with the latter. The light transmitted through the red medium was first measured, and then through the blue. If the first and last of the readings compared favourably with each other, the series was taken as worthy of confidence. If, on the other hand, great fluctuations were observed, which was sometimes the case owing to the occasional irregularities of the motive power, and to impurities in the carbons themselves, a fresh set of readings was taken. As often as possible readings were taken through the blue and red media at the same number of revolutions per minute of the armature. This was not always practicable or even necessary. This will explain the reason of the variable revolutions recorded in the tables. I may remark that the revolutions were always taken at the commencement and end of each set of readings, and if these were tolerably close the mean was taken as the correct value for the mean of the readings. With any great variation, say of more than ten revolutions, the readings were rejected altogether. It was found difficult to make a comparison with a standard or pair of standard candles, owing to the small distance from the screen they sometimes occupied; hence an intermediate light from a paraffin lamp was made use of, which before and after each series of readings was compared with the standard candle. The variation of the lamp light was very small, ranging from 10·23 to 10·05. The light from the electric lamp was admitted into the observing-room through an aperture in the wall of about 18 inches square, and great care was taken that any reflected light was cut off the screen.

In addition to the optical readings, an endeavour was made to secure a record of the actinic value of light. Paper sensitised with silver chloride was exposed to the light at a distance of three feet from the carbon points, one strip was placed behind a cell filled with quinine sulphate, whilst another was exposed to the full action of the unshaded light. The times of exposure varied between one and ten minutes. The intensity of the actinism was measured by Roscoe's method, which need not be described. The curve obtained from the paper exposed behind the quinine cell is practically identical with that obtained optically from the blue components when any one point in the former curve is made to correspond to a point in the latter which has the same abscissa. The following tables give the results of the experiments. The horse-power given is the total horse-power recorded less that required to drive the machine with the brushes up.

Expenditure of H.-P.

Revolutions.	H.-P.
240	1·0
308	1·6
350	2·5
400	3·8
460	5·6
480	5·7
520	7·9
550	8·5
565	9·0

Integration of Blue Light.

Revolutions.	Candles.
240	360
308	660
350	750
425	1,700
460	2,500
490	3,000
520	4,860
550	4,800
565	6,500
580	6,000
600	10,100

Integration of Red Light.

Revolutions.	Candles.
240	180
308	280
460	860
500	1,080
520	1,300
540	1,620
575	1,520
580	2,100
600	2,400

Integration of Actinic Power.

Revolutions.	Candles.
350	890
460	2,750
560	9,000
580	10,050
600	11,020

Currents. Machine No. I.

Revolutions.	Tangents.	Remarks.
300	1·15	1st set of experiments.
350	1·31	
460	1·80	
540	2·47	
200	·51	Experiments during which the illuminating power was measured.
308	·90	
370	1·33	
425	1·48	
460	1·66	
500	1·96	
580	2·20	
600	2·30	

The following is a statement, furnished me by Captain R. Y. Armstrong, R.E., of the electrical conditions of the circuit.

The resistance of the stationary wire = 4·46 ohms.

" " magnetising coil = 0·44 ohm.

In the generator the resistance of the light circuit coil = 0·24 ohm.

The light coils were in divided circuit, as were also the right and left stationary coils.

When driven at from 375 to 383 revolutions, the resistance of the voltaic arc was about 0·18 ohm; the other resistances in the circuit were 0·7 ohm. The electro-motive force of the machine when driven at the above speed was 111 volts, a measure which has been arrived at by Captain Armstrong from other experiments. The electro-motive force between 375 and 383 revolutions of the armature was assumed to vary as the number of revolutions, an assumption which was borne out as practically correct by other measurements made for the purpose. In order to ascertain what effect the insertion of resistance had on the current, the following experiment was undertaken by Captain Armstrong with a smaller form of Gramme machine, called Machine No. II. Two resistances were inserted in the circuit for two different sets of readings, in the first case 1·1 ohm of total resistance, in the other 2·72.

The following table refers to these experiments:—

Currents. Machine No. II.

Revolutions.	Tangents.	Remarks.
398	1·40	1st set of experiments.
490	1·88	
846	3·08	
264	·10	2nd set of experiments.
280	·12	
288	·17	
384	·38	
438	·48	
458	·53	
484	·56	
534	·67	
692	·92	
842	1·25	
862	1·33	
1,014	1·45	

It will be noticed that practically the electro-motive force increases directly as the number of revolutions of the armature, a result which might have been expected theoretically. It will also be seen that the current for any given number of revolutions varies inversely as the resistance in circuit, or, in other words, that the electro-motive force for a given number of revolutions is constant.

In any results, therefore, which are given descriptive of the light produced by any machine, the following should be noted:—

Number of revolutions of armature;
Resistance in circuit;
Horse-power expended;
Colour of light measured;
Electro-motive forces

together with the size of the carbons employed, and other obvious details.'—*Proceedings of the Royal Society.*

THE PROPAGATION OF ELECTRICITY IN CONDUCTORS.

By M. MASCART.

ACCORDING to the theory of Ohm, the differential equations which govern the propagation of electricity in conductors are identical with those which Fourier has established for the conduction of heat. The general integral of Fourier's equation is known under several forms, but the consideration of limited values sometimes renders the numerical applications difficult; we can, on the contrary, choose conditions which lead to a more simple solution, which in reality is applicable to the majority of observed phenomena.

Let us suppose that a cylindrical wire of indefinite length, primitively in a neutral state, has one end raised to a constant potential v_1. The wire will electrify itself progressively, and the potential v at one point is a function of the time t, and the distance x from the point considered at the electrified end. If we neglect the loss of electricity which takes place by the insulator, as well as the phenomena of induction, this potential satisfies the equation.

(1.) $$\frac{d^2v}{dx^2} = \frac{y}{cs} \qquad \frac{dv}{dt} = a^2\frac{dv}{dt}$$

in which y means the electric capacity of unit length of the wire, c the co-efficient of conductivity, and s, the sectional area.

For a second wire placed in the same conditions as the first, and having its nature defined by another co-efficient a', we have similarly,—

(2.) $$\frac{d^2v'}{dx'^2} = a'^2\frac{dv'}{dt'};$$

put $x' = mx$, $t' = nt$, m and n being constants, and consider v′ as a function of x and t, the equation (2) then becomes

$$\frac{d^2v'}{dx^2} = \frac{x'^2\, m^2}{n} \quad \frac{dv'}{dt}$$

If we choose the co-efficients m and n so as to get

$$a^2 = \frac{a'^2\, m^2}{n}$$

that is to say,

$$\frac{a^2\, x^2}{t} = \frac{a'^2\, x'^2}{t'},$$

the potentials v and v′ satisfy the same differential equation and the same limited conditions; they represent, therefore, the same function of x and t.

Thus, when we consider indefinitely long wires, which in practice are equivalent to wires long enough for the duration and propagation to have a sensible value, the potential v only changes when the ratio $\frac{a^2\,x^2}{t}$ preserves the same value; it is then a function of this ratio. It follows from this that the time necessary for a distance x to produce a given potential, or more exactly a determinate fraction of the initial potential, is proportional to the square of the distance and to the co-efficient a^2 which characterises the wire.

In these conditions equation (1) only involves in reality an independent variable, and if we put

$$v = \left(\frac{ax}{2\sqrt{t}}\right) = f(y)$$

it becomes

$$\frac{d^2v}{dy^2} + 2y\,\frac{dv}{dy} = 0$$

which easily gives

$$v = c\int_0^y e^{-y^2}dy + c'$$

The constants C and C′ will be determined by the limiting conditions; for $t = o$ or $y = \infty$, we have $v = o$; for $t = \infty$ or $y = o$, we have $v = v_1$. It follows, therefore, that

$$\int_0^\infty e^{-y^2}dy = \frac{\sqrt{\pi}}{2}$$

(4) $$v = v_1\left(1 - \frac{2}{\sqrt{\pi}}\int_0^y e^{-y^2}dy\right)$$

The integral which involves this formula cannot be simply expressed, but it can be obtained from tables.

Suppose now that the potential v, be maintained at the end of the wire only during a time T, and that that point is afterwards put to earth. The potential at another point will be determined by the superposition of two states, the first being due to the permanent potential v_1, set up at the beginning of the time, the second to the permanent potential $-v_1$, established only at the epoch T. The value of v relative to each of the states being a function of the time passed since the beginning of the resultant potential U at the same point will be

$$u = v\,(t) - v\,(t - T)$$

and if the time T is infinitely small

$$U = T\frac{dv}{dt} = T\frac{dv}{dy}\frac{dy}{dt}$$

we deduce from it

(5) $$u = T\frac{v}{\sqrt{\pi}}\frac{y}{t}\,e^{-y^2} = T\frac{v_1}{\sqrt{\pi}}\frac{1}{t^{\frac{3}{2}}}\,e^{-\frac{a^2 x^2}{4t}}$$

This expression has been given by Sir William Thomson; we see that the value is only a simple function of the ratio $\frac{a^2\,x^2}{t}$

The instantaneous contact of the end of the wire with one of the poles of a pile gives place, as we see by the value of u, to a species of electric shadow which propagates itself after a law quite complex, and which *s'etale* in proportion as it is propagated. The epoch T at which the maximum of the potential takes place at a point is determined by the condition

$$\frac{du}{dt} = o$$

which gives

$$T = \frac{a^2\,x^2}{6} = \frac{1}{6}\,\frac{y}{cs}\,x^2.$$

This time T may be considered as expressing the duration of propagation of an electric wave; it is proportional to the square of the distance, and is here expressed in absolute values in function of the electric constants of the thread.

We determine similarly, by calculation or by a geometrical construction, the wave which results from the successive contact of the wire with the positive and negative poles of the battery, during equal or unequal times and after different intervals. We can thus obtain by several successive contacts a wave much shorter than with a single contact, and this property is utilised in telegraphic signals.

The formulas (4), (5), and (6), represent exactly the phenomena which are produced in the ingenious experiments of M. Gaugain upon the propagation of electricity in bad conductors, such as threads of cotton and columns of oil.

If we put a point of the wire or its further extremity in contact with earth by a galvanometer of very high resistance, these formulas give also the intensity of the current derived at a point, the intensity of the current at the extremity of the wire, and the time necessary for the maximum to be attained, in both cases we can thus resolve, by sufficiently simple considerations, the most part of the problems relative to the propagation of telegraphic signals in submarine cables.

AN action in Chancery has been commenced by Mr. Morgan Brown against Mr. Ladd, to restrain the latter from making and selling telephones.

Notes.

A CURIOUS phenomenon has been observed on a property at Vernon, in France. Some five or six years ago, a garden planted with cherry-trees and gooseberry bushes was struck with lightning, a deep hole, about 10 centimetres in diameter, being made in the ground. Subsequently, everything died about the hole, the death circle becoming larger every year. It is now stated to be 7 metres in diameter, and has just reached a cherry-tree planted twelve years' ago, whilst some replanted gooseberry-bushes died in two years. The part the lightning has played in producing the phenomenon has not as yet been explained.

THE Friday evening lecture at the Royal Institution, on May 10th, was delivered by Sir William Thomson. Dr. Siemens being in the chair. The subject of the discourse was "The effects of stress on the Magnetisation of Iron, Cobalt, and Nickel." There was no elaborate preparation of lime light effects to dazzle the vulgar sense, no straining after startling paradoxes. The experiments were few and simple, and the language quite spontaneous; yet the lecture was illuminated by those splendid flashes of intelligence, which seem as natural to great and veritable genius as the scintillations are to the stars. Sir William first pointed out that certain magnetic bodies possessed the power of retaining magnetism in a greater degree than others, iron possessing this force in a high and nickel and cobalt in a lesser degree; para-magnetic bodies do not possess this power. The magnetic property in bodies might be different in different directions, that is it varied according to the structure of the body. Some bodies could be isotropic, that is, their magnetic properties might be the same in all parts of their mass; thus a lump of dough, when uniformly kneaded and placed between the poles of a powerful magnet, was unaffected; but when compressed in one direction, became influenced by the magnetism. The influence of the magnetism of the earth on a bar of soft iron was next pointed out, the bar becoming magnetic when held in the line of the dipping-needle, the upper end of the bar always taking the same magnetism, even when the ends were reversed, after the bar had been held in one direction. One interesting experiment consisted in inverting a bar of iron, part of the weathercock of Oxford Cathedral, which had stood upright in the steeple for over 300 years, and had been carefully treasured by Faraday in the same position, with the same end up, ever since. It would have been a scientific sacrilege to have done so idly, but the object was to see whether, after three centuries of fixity in position, it had acquired a fixity of magnetisation. No one had a better right to perform the act than the philosopher to whom Faraday has handed on the lamp, and no one could have done it with more reverence. The result could not be predicted, and it was awaited with considerable interest. Before inversion, the upper end of the bar was a true north-pole by virtue of its position, and the lower end a true south-pole. After inversion, the latter became a true north-pole, and the former upper end a true south-pole, showing that the magnetic induction of 300 years had not taken a permanent hold upon the iron. The effect of striking a bar of iron, cobalt, or nickel, held in the line of the dipping-needle, was shown to give a very perceptable amount of magnetism to them, even when the blows were very slight. It was pointed out that this effect was very much more considerable in long than in short bars, and that therefore it was advisable to avoid the use of such bars, long in proportion to their breadth, for stanchions in ships, as compass errors might become considerable from the magnetism which such bars might acquire. Villari's discovery was next alluded to, viz., that the effect of stretching a magnetised wire was to increase its magnetism, this increase reaching a maximum at a certain point and then decreasing as the strain was still further increased. On the relaxation of the strain, the magnetic condition of the wire was nearly but not quite restored to its normal power. Sir William had extended these experiments by determining the effect of transverse strains such as is produced by applying hydraulic pressure in an iron tube; this transverse strain was found to *de*crease the magnetic force in the tube when the magnetic power was feeble, a maximum being reached at a certain strain; when the magnetism was strong the opposite effect was produced, a transverse strain producing an *in*creased effect, rising to a maximum at a certain strain. The effect of torsion on a wire was found to be to decrease the magnetic power in a wire, no matter which way the twist was made; but on the relaxation of the twist, the magnetic power remaining in the wire was less than it was at first. In conclusion, Sir William said that the values of the discoveries did not necessarily lie in their immediate practical application, but in the fact that every new law brought to light added a link to the chain of human knowledge, and must be a gain to mankind. We hope, through the kindness of Sir William Thomson, to be able to give a more complete account of his interesting researches on the subject in our next issue.

TELEPHONIANA.—After the recent lamentable accident which happened near Hartford, Conn., U.S., to an excursion train returning from one of Moody and Sankey's revival meetings, over twenty Hartford physicians were promptly called to the scene of the disaster by means of private telephone wires centreing in a chemist's shop. For fire-alarms, and accidents of a serious kind, requiring prompt and collective assistance, the speaking telephone may yet prove invaluable.

ACCORDING to M. Demoget, of Nantes, a continuous humming sound is produced by a *trembler*, operated by a bundle of soft iron wire, introduced into a bobbin five centimetres long, wound with four layers of silk-covered copper wire, half a millimetre in diameter, through

which a current is made to pass. If a telephone deprived of its diaphragm and put in circuit with a line to the other end of which a second telephone is attached, be brought near this contrivance, the humming is heard in the second instrument. It is to be remarked that the maximum effect is obtained when the core of the exploring telephone is of soft iron, and the minimum when it is presented to the middle of the induction bobbin. In seeking to determine the range or field of the inductive action by finding the position of the first telephone, at which the sound ceased to be heard in the second telephone, it came out that the induction bobbin may be considered as a magnet, having at its middle a neutral line, and that it forms two inductive sections symetrically opposed. In the particular case in question, the inductive field was bounded by a double paraboloid, with its major axis 0·55 metres long in the prolongation of the magnetic bundle, and its greatest perpendicular diameter 60 centimetres. The sounds in the second telephone are audible when the telephone is near the ear. M. Demoget suggests the use of this arrangement in connection with the Morse key, to give short and long sounds, in preference to the Morse sounder.

It is our pleasant duty to record another duplex success for Muirhead's Artificial Cable. The principal achievement for last year was the duplexing of the Aden to Bombay Cable; this year Muirhead's has just been successfully applied to the Direct United States Cable. It will be a little startling to electricians to hear that as many as fifty words a minute can now be transmitted through an Atlantic cable, twenty-five either way. While America has of late taken the lead in the invention of land-line apparatus, it is satisfactory to the profession in England to know that all the important advances of late years in submarine work, the siphon recorder, the curb-sender, the Muirhead duplex system, are due to Englishmen.

Messrs. J. and A. Muirhead have also successfully duplexed the telegraph line between London and Enden, in Germany. This line is composed of a long land-line from London to Lowestoft and a cable to Enden, and this double character renders the problem of duplexing it somewhat complicated. The artificial line by which the difficulty has been overcome by Messrs. Muirhead consists of their artificial cable for the cable portion, and for the land-line portion a rheostat of silk-covered wire, rendered inductive by a spiral of fine metal foil wound over the silk. This wire has, we believe, been patented by them, and as its inductive capacity can be adjusted to that of the land-line it is desired to balance, it may make a better artificial line for duplexing land-lines than the ordinary resistance coils and condensers now in vogue.

The Police-stations of Boston, U.S., have been fitted up with telephones.

In the *Petit Journal* of Paris, for Nov. 22, 1865, is to be found the following passage on the Discovery of the Transmission of Sounds and Words by the Telegraph:—"A new discovery, which will produce immense results in its application to the arts and industries, has recently been added to the numerous wonders of this century: it is the transmission of the sounds of the voice by telegraph. The author of this invention is Signor Manzetti of Aosta, who is also the inventor of a celebrated automaton. He transmits words with the ordinary telegraph wire, and with an apparatus more simple than that which at present serves for despatches. Henceforth, two merchants may communicate instantaneously their business affairs between London and Calcutta, informing each other of their speculations, agreements, &c. A number of successful experiments have been made, which confirm the practicality of this invention. It also transmits musical notes, &c., &c." It appears that many other journals have published notices of this apparatus, among others the *Diritto* of Rome, for July 10, 1865; the *Echo d'Italia* of New York, August 9, 1865; the *Italie* of Florence, August 10, 1865; the *Commerceo d'Italia* of Genoa, December 1, 1865; the *Verita* of Novari, January 4, 1866; the *Commercio di Genova*, January 6, 1866. Manzetti was a poor artizan, and no one took him in hand.

The Aërophone.—Something ought to be done to Mr. Edison, and there is a growing conviction that it had better be done with a hemp rope. Mr. Edison has invented too many things, and almost without exception they are things of the most deleterious character. He has been addicted to electricity for many years, and it is not very long ago that he became notorious for having discovered a new force, though he has since kept it carefully concealed, either upon his person or elsewhere. Recently, he invented the phonograph, a machine that catches the lightest whisper of conversation and stores it up, so that at any future time it can be brought out, to the confusion of the original speaker. This machine will eventually destroy all confidence between man and man, and render more dangerous than ever woman's want of confidence in woman. . . . This country has long suffered from excessive talk. Had nine-tenths of our citizens, who have been born during the last fifty years, been absolutely dumb, the Republic would doubtless have preserved its pristine purity. It is the interminable talk of Congressmen and other leading citizens, that is the source of all our public woes. Talk is likewise the bane of private life. With dumb wives there would be no need of divorce courts, and with dumb husbands, home might become a blessed reality instead of a poetic dream. And yet, knowing full well that talk is a monster of such hideous meaning that to be hated needs only to be constantly heard, Mr. Edison has devised an instrument by which the range of conversation is extended from a few feet to four miles.—*New York Times.*

THE ROYAL SOCIETY SOIRÉE.—The Annual Soirée of the Royal Society was held at the society's rooms in Burlington House on the 1st inst. A large and distinguished company was present. Amongst the objects exhibited, those of an electrical nature came in for a fair share of notice. The Telephone Company exhibited various forms of apparatus; the "telephone harp," of Mr. F. A. Gower, being the most prominent instrument. This invention enables some of the sonorous properties of the telephone to be rendered perfectly audible to a large audience. The telephone being a most unsatisfactory instrument for audible demonstration to a large audience, the harp of Mr. Gower will prove very useful for keeping up the interest of lectures on the subject. Mr. Henry Edmunds exhibited his method of showing variations in the pitch of sonorous vibrations by means of a revolving vacuum tube; this apparatus was first exhibited at the Royal Institution on the occasion of Mr. Preece's lecture on the telephone at that place, and a short description of it was given by us in the account of that lecture. In the same room with the foregoing, Mr. Robert Sabine exhibited his discovery of the effect of light on selenium in generating an electro-motive force. In the smaller library Mr. Ladd exhibited a large Holtz electrical machine, and specimens of Byrne's pneumatic battery. Messrs. Siemens Bros., in the same room, exhibited one of their dynamo-electric machines capable of giving an electric light equal to 1,200 normal sperm candles; an electric lamp was also shown by the same firm. Amongst the other scientific apparatus, the "phonograph," shown in action by Mr. Stroh, and explained in a short lecture by Mr. W. H. Preece, naturally excited primary attention. The "Mechanical Chameleon," the invention of Mr. A. B. Kempe, excited much interest amongst the more scientific portion of the visitors. This ingenious apparatus, by mechanical means, enables all the graduations of tint of any two colours to be obtained and to be varied at will, the one tint dissolving gradually or suddenly into any other, or remaining stationary if required. Mr. Francis Galton, F.R.S., exhibited a curious optical instrument, by which portraits of different persons could be combined so as to form a new face possessing the characteristics of each individual portrait. Mr. Nathaniel Holmes showed in action his flashing light signal apparatus, in which a brilliant "flare" is produced by the action of water dropping on phosphuret of lime. Besides the foregoing, many other objects of considerable interest were exhibited, which want of space forbids us describing.

MR. ALFRED M. MAYER, in a paper to *Nature*, states that the profile of the impressions made on the tinfoil of the phonograph in speaking the word *bat* (this being the only word so far experimented with) bear a close resemblance to the contours of the flame of König when vibrated by the same compound sound.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
April, 1878 ...	42,520	10,361	3,100	746	10,000	32,210	21,753	16,946	... ...	9,543	2,125	9,511	*5,295
April, 1877 ...	18,980	11,539	4,703	981	6,390	39,861	23,068	16,151	... ...	11,324	2,362	10,295	7,729
†Total Inc. 1878	76,630	... ...	166	... ...	1,770	691	... ...	3,483	... ...	... ...	... ...	... ...	247
†Total Dec., 1878	... ...	74	... ...	245	... ...	... ...	1,260	... ...	... ...	1,055	2,203	2,409	... ...

* Estimated. † Compared with same period 1877.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).

Patents.

1623. "Improvements in the means and apparatus for kindling and extinguishing, or reducing lights by electricity for signalling and other purposes."—J. PINTSCH and J. SCHULKER, April 23.

1644. "Improvements in means for recording sounds, and in reproducing such sounds from such records."—T. A. EDISON, April 24.

1677. "An improved electrical signalling apparatus chiefly designed for use in ships."—G. ZANNI, April 25.

1756. "Improved electric apparatus for communicating between railway stations and trains, between trains, and between different parts of trains."—W. CLARK (commuicated by E. J. J. de Baillehache), May 1.

1779. "Improvements in speaking telephones, and in apparatus connected therewith."—J. F. BAILEY, (communicated by G. M. Phelps), May 2.

1783. "Electric and electro-pneumatic bell indicators."—J. W. EDMUNDSON, May 3.

ABSTRACT OF SPECIFICATIONS.

2982. "Electric lamps."—EMILE RAYNIER, Paris. Dated August 3, 1877. 8d. This consists in a regulator for the carbon points, and has been fully described in the TELEGRAPHIC JOURNAL for Feb. 1st, 1878.

2997. "Galvanic batteries."—J. and S. J. COXETER. Dated August 7, 1877. 4d. This consists of a manganese-zinc battery for medical purposes, contained in a vessel of waterproof fabric. The manganese and carbon is powdered, the positive pole being of platinum or a platinised surface.

3034. "Electric signalling apparatus on railways."—C. LECOQ, France. Dated August 9, 1877. 2d. This consists in a plan (undetailed) for working a semaphore and lamp signal by electro-magnetism. *(Not proceeded with.)*

3050. "Receiving instruments and relays."—W. H. PAGET HIGGS. Dated August 10, 1877. 6d. This designs to utilise the lessening of friction by the passage of an electric current, for the purpose of receiving relays. One method consists in providing a continuously revolving disc of paper, or other suitable absorbent substance, moistened with water or a saline solution. On the moistened disc is placed a metal disc which is kept from revolving by a torsional or elastic force. The two discs are connected in circuit with the line. When the current passes, the usual friction between them is reduced, and the metallic disc consequently turns in a direction opposite to the rotation of the paper disc. An arm or tongue attached to the metallic disc is thus moved to and fro in obedience to the signal currents, and makes or breaks contact, or produces visible signals.

3139. "Receiving instruments of electric telegraphs."—J. and A. MUIRHEAD. Dated August 17, 1877. 6d. This consists of a recorder, in which a rectangular coil of wire is made to rock to and fro between the poles of a magnet when the signal currents from the line are made to traverse it. The coil is suspended by two spiral springs coiled in opposite directions, and rigidly attached at their inner ends to the top and bottom of the coil, the whole being sustained by a single fibre at the top. A siphon, dipping in ink, is used as the marker. The ink is stimulated to flow by the discharges from a Ruhmkorff coil.

3161. "Apparatus for steering ships." — JEAN CASELLI, Florence. Dated August 20, 1877. 8d. The object of this invention is to put the rudder of a ship under the control of the captain directly, without the intervention of a helmsman. It is effected by means of a special suction and force pump, hydraulic presses, an auto-directive compass, an indicator of the rudder movements, an auto-motive marine telescope, and an automatic electric manipulator. By this arrangement, the deviation of the compass from the proper course can be made to work the rudder and guide the ship.

3187. "Magneto-dynamo electric machine."—PAUL JABLOCHKOFF, Paris. Dated August 22. 6d. The principal feature of this machine consists in making the armature consist of two soft iron discs, or mounted on an iron axis, with the coil between, so that the core takes the form of two iron cheeks, connected by the bar of the axle. These cheeks are caused to revolve, and the coil remains stationary or revolves with them. The cheeks are magnetised by external magnets inductively, so that each cheek is polar at its centre and circumference. To facilitate this inductive magnetisation, the periphery of each disc is formed into tooth-like projections which are attracted by the poles of the magnets. A tooth of one cheek is situated so as to come between two teeth of the other.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—I have great pleasure in seeing an investigation of the interesting problem of determining the true copper resistance during earth currents, and in having given rise to Mr. Fujioka's critical examination of my geometric mean formula.

The resistance of the battery is of no *practical* consequence in this test, particularly when we employ one like the Leclanché's of small internal resistance, and the formula referred to (Messrs. Clark & Sabine, page 29) will *practically* give the same result whether the value f (the resistance of the battery) is inserted or not.

I should like Mr. Fujioka to understand that my geometric mean is an *empiric* formula, and that I do not and did not urge, that A E represents x, the true resistance of the line, but that I find *empirically* that A E, representing X, the mean proportional between r and R, is the true, *practically* the true expression for the resistance of the line A B.

I fully admit that my diagram only represents the potential curve in a small part of the bridge, and that the expression $\frac{2 R r}{r + R}$ is not equal to $\sqrt{r R}$ unless r and R are equal to one another. But whether $\frac{2 r R}{r + R}$ is equal to $\sqrt{r R}$ is not the question. $\frac{2 r R}{r + R}$ is a mathematically true expression when the resistance is taken *by deflection* reproduced through a known resistance, whereas in testing with *the Wheatstone bridge*, it never can hold good, except when there is no natural current flowing, *i.e.*, when $p = p'$ (figure 3), and $r = R$. $\sqrt{r R}$ is the constructed mean proportional between the resistances obtained in measuring with *the Wheatstone bridge*, *empirically* found to give the correct or about the correct value, whether strong natural currents are flowing or not.

In conclusion, I beg to remark that in all cases where the difference between the zinc and copper current reading is so great, that the *arithmetic mean is considerable*. I have had it 30 to 40 ohms *higher* than the

real resistance of the line. I find that *my geometric mean* ALWAYS *gives the true resistance within* TWO or THREE *ohms*, which, as every practical electrician will admit, must be considered a very satisfactory result.

Yours faithfully,

18, Prospect Terrace, CHRS. DRESING.
Aberdeen, 8-5-78.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In the course of some experiments lately with the Bell telephone, it occurred to me to try it instead of the galvanometer in laboratory and battery testing. The results were so satisfactory, that I now use both instruments indifferently.

From its simplicity, compactness, and portability, and its extreme delicacy withal, I feel satisfied the telephone will greatly supersede the galvanometer in laboratory experiments; and I have, therefore, great pleasure in drawing the attention of electricians to this, the last and not least useful application of the wonderful little instrument.

It can never, I fear, be employed in ordinary lime testing, on account of its great sensibility to earth and atmospheric currents.

J. J. FAHIE,
Memb. Soc. Tel. Engineers.

Teheran, Persia,
April 10, 1878.

[As our readers are aware, this application of the telephone was suggested and tried with success some time ago.—ED. TEL. JOUR.]

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

AT the ordinary general meeting of this Society, held at Great George Street, on the 10th ult., a paper was read by Mr. C. V. Walker, F.R.S., on "The unit of the Birmingham Wire Gauge." The paper purported to deal, not with the whole subject of gauges, but more especially with the graduations found by Mr. Walker on a particular gauge given to him in 1860 by Messrs. R. Johnson and Nephew.

After dwelling upon the chaos of existing gauges and the importance to telegraph engineers and others of a standard wire gauge, based upon some definite principle, the author said that a careful examination of the copy above referred to had led him to the conclusion that the unit of that particular copy of the B. W. G. was the $\frac{1}{640}$ of an inch. This unit, named by Mr. Walker the C. V. W. unit, was probably arrived at in the first instance by splitting up the inch into $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, and $\frac{1}{640}$, and assigning values to intermediate sizes differing by multiples of $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$, or $\frac{1}{80}$. Table 1 gives the numbers complete of a gauge from $\frac{1}{2}$ inch or 320 C. V. W. units down to number 46, which comes to be one unit. The copy in Mr. Walker's possession was engraved only as far as number 30; the remaining numbers were run out suggestively by the author, by continuing the successive diminutions of one unit or $\frac{1}{2}$ unit. A reference to col. 3 will show that the successive diminutions of diameter are respectively as follows: 40, 20, 10, 8, 4, 2, 1, $\frac{1}{2}$, the transmitters taking place at numbers + .0, 4, 12, 17, 21, 25, and 33. It was claimed for this system of sub-division that if it was not *the* true standard of the B. W. G., it was, at least, one upon which *a* standard could be based, with values calculated upon a much more definite system than was to be found elsewhere. It has also the advantage of fixing the sizes of our more familiar wires, such as numbers 8 and 11, at what they are *approximately* known to be. Thus, number 11 is fixed at $\frac{1}{8}$ inch (·125), which is the size specified for it by the Postal Telegraph Department.

TABLE 1.

1. Nos.	2. Diameters.	3. C. V. W. Units.	1. Nos.	2. Diameters.	3. C. V. W. Units.
4 0	$\frac{1}{2}$	320	21		22
3 0	$\frac{14}{32}$	280	22	$\frac{1}{32}$	20
2 0	$\frac{3}{8}$	240	23		18
			24	$\frac{1}{40}$	16
0	$\frac{11}{32}$	220			
1	$\frac{5}{16}$	200	25		15
2	$\frac{9}{32}$	180	26	$\frac{7}{320}$	14
3	$\frac{1}{4}$	160	27		13
			28	$\frac{3}{160}$	12
4	$\frac{15}{64}$	150	29		11
5	$\frac{7}{32}$	140	30	$\frac{1}{64}$	10
6	$\frac{13}{64}$	130	31		9
7	$\frac{3}{16}$	120	32		8
8	$\frac{11}{64}$	110			
9	$\frac{5}{32}$	100	33		$7\frac{1}{2}$
10	$\frac{9}{64}$	90	34		7
11	$\frac{1}{8}$	80	35		$6\frac{1}{2}$
			36		6
12	$\frac{9}{80}$	72	37		$5\frac{1}{2}$
13	$\frac{1}{10}$	64	38		5
14	$\frac{7}{80}$	56	39		$4\frac{1}{2}$
15	$\frac{3}{40}$	48	40		4
16	$\frac{1}{16}$	40	41		$3\frac{1}{2}$
17	$\frac{9}{160}$	36	42		3
18	$\frac{1}{20}$	32	43		$2\frac{1}{2}$
19		28	44		2
20	$\frac{3}{80}$	24	45		$1\frac{1}{2}$
			46		1

Mr. Latimer Clark, who has long been concerned at the confusion that reigns, took the question in hand some years ago, and presented a paper "On the Birmingham Wire Gauge," to the *British Association*, which was read at Dundee, in September, 1867; followed by another, read at Exeter, in August 1869.

In his former paper he speaks of the origin of the system, and its date being unknown; of there being no authorised standard in existence; and of a great number of gauges being in practical use, which differ from each other to a serious extent.

He has prepared a "Table of the sizes of the Birmingham Wire Gauge," as given by different authorities (thirteen in all), diameters in mils. or thousandths of an inch. If all other evidence were wanting, this table alone bears witness to the fact, put on record by Mr. Clark, that there is no authorised standard in existence.

A few illustrations of the sizes assigned by the several authorities to certain wires familiar to us have been extracted from Mr. Clark's tables, and reduced to C. V. W. units in Table 2. It will be seen that Warrington, Culley, and Rylands, 1862, are alike throughout; they are alike also in the complete table, and are doubtless derived from the same source, and may therefore be counted as one authority. There are no less than nine different sizes attributed to our No. 8, and not one of them correspond with the Johnson and Nephew's size, which is a trifle higher than any. No. 11 is more fortunate. The value assigned to it, one-eighth of an inch, is very consistent, and it has the majority of advocates. It comes out in a whole number, 80 C.V.W. units, or 125 mils. This is seen in col. 2 of Table 3, which is taken from p. 178 of *Preece and Sive-*

wright's Telegraphy published in 1876. Col. 3 gives the mils. of col. 2 in C.V.W. units. Col. 4 actual values in C. V. W. units to the respective wires, numbered in cols. 1 and 5.

TABLE 2.

Diameters in C. V. W. Units of Certain Selected Wires as given by various Authorities.

Authorities.	No. 6.	No. 8.	No. 11.	No. 14.	No. 18.	No. 22.	No. 35.	No. 40.
C. V. W. Unit	130	110	80	56	32	20	6½	4
L. C. . .	126·9	101·5	72·6	51·3	33·2	21·3	4·9	2·8
Warrington .	128	108·8	80	54·4	32	19·2		
Silvertown .	124·1	103						
Culley . .	128	108·8	80	54·4	32	19·2	5·0	2·1
Rylands, 1862	128	108·8	80	54·4	32	19·2		
Rylands, 1866	128	101·7	74·8	50·5	30	17·9		
Holtzapffel .	129·9	105·6	76·8	53·1	31·3	17·9	3·2	
Molesworth .	128	106	80	53·1	31·3	17·9	3·2	
Schaw, R.E. .	133·3	109·9	80	56	33·3	19·9		
Cocker . .	128	102	76·8	57·6	32	19·2	3·8	
Bartholomew .	133·7	107·8	80	54·4	33·9	19·2	3·5	
Whitworth .	128	105·6	76·8	54·4	32	17·9	3·2	
Hall . .					27·5	20·4	5·5	

With so many conflicting elements before him, which it was impossible to reconcile, Mr. Clark expressed in his paper a hope that the British Association might appoint a committee, and "issue a gauge under their authority, bearing the title of the British Association gauge, or British gauge." Failing this, he took the matter in hand himself. He was "inclined to think it probable that the original gauge may have been formed by taking as its basis No. 16 bell wire, having a diameter of $\frac{1}{16}$ of an inch, and that each succeeding size up to No. 1 was formed by successive additions of 25 per cent. to the weight. This would be equivalent to successive increments of 11·8034 per cent. to the diameters . . . . "

TABLE 3.

Preece and Sivewright's Diameters of Certain Wires. (Telegraphy, p. 178.)

1	Preece and Sivewright's Values. 2	3	C. V. W. Units. 4	5
Nos.	In Mils.	In C. V. W. Units.		Nos.
4	240	153·6	150	4
5	220	140·8	140	5
6	200	128·0	130	6
7	180	115·2	120	7
8 G.P.O.	170	108·8	110	8G.P.O.
8	165	105·6	110	8
9	150	96·0	100	9
10	135	86·4	90	10
11 G.P.O.	125	80·0	80	11G.P.O.
11	120	76·8	80	11

Table 4 gives the proposed British gauge founded on these principles and suggested by Mr. Clark in his Dundee paper.

The gauges themselves, Mr. Walker remarked, are, indeed a fertile source of error.

This question has recently been taken up in America, and the *Journal of the Franklin Institute*, for February, 1878, contains a "Report on a Standard Wire Gauge," read before the American Institute of Mining Engineers, at the Autumn meeting, October, 1877, dwelling mainly upon the gauges themselves, which they say should be simple in construction, not readily worn, easy of adjustment, and not too expensive. Reference is made to (1) those like our ordinary gauge, made with slots, and the sides of which they state are not always parallel, as of course they should be; (2) those with holes, as the Whitworth wire gauge; (3) those of a V, cut in steel, or of two steel bars; (4) sliding calipers with verniers; (5) the micrometer screw-gauge; and they decide in favour of the latter, with the sizes to be expressed in thousandths of an inch (or mils.); elsewhere spoken of as fractions of an inch.

TABLE 4.

PROPOSED BRITISH GAUGE.

Areas increasing 25 per cent. Diameters increasing 11·8034 per cent.

Nos.	Areas in square inches.	Diameters in "Mils."	Nos.	Areas in square inches.	Diameters in "Mils."
00000	·2878182	605·3	19	·0016990	46·5
0000	·2302546	541·4	20	·0013591	41·6
000	·1842037	484·3	21	·0010873	37·2
00	·1473630	433·1	22	·0008699	33·3
0	·1178904	387·4	23	·0006959	29·7
1	·0943123	346·5	24	·0005567	26·6
2	·0754498	309·9	25	·0004454	23·8
3	·0603598	277·2	26	·0003563	21·3
4	·0482879	247·9	27	·0002851	19
5	·0386303	221·7	28	·0002280	17
6	·0309042	198·3	29	·0001824	15·2
7	·0247234	177·4	30	·0001459	13·6
8	·0197787	158·7	31	·0001167	12·2
9	·0158229	141·9	32	·0000934	10·9
10	·0126583	126·9	33	·0000747	9·7
11	·0101267	113·5	34	·0000597	8·7
12	·0081013	101·5	35	·0000478	7·8
13	·0064811	90·8	36	·0000382	6·9
14	·0051848	80·3	37	·0000306	6·2
15	·0041479	72·6	38	·0000245	5·6
16	·0033183	65	39	·0000196	5
17	·0026547	58·1	40	·0000157	4·5
18	·0021237	52			

They found, as we do, that gauges "not only differ according as they are made by different manufacturers, but in a package of a dozen, made by the same manufacturer, there were often very perceptible and annoying differences. . . . Neither the number nor the diameter is ordinarily correct, so that there is a double source of inaccuracy, as the number does not express the exact diameter, nor the diameter the number."

Mr. Walker, in concluding his paper, truly remarked that while we have the true time and the standard foot and yard and pound weight, open to all the world for reference on the outer walls of the Royal Observatory, Greenwich, it is almost absurd to say that we have no means of knowing for certain what the diameter of an article in such common use as No. 8 iron wire ought to be.

AT the ordinary general meeting, held on the 8th instant, a paper by Dr. Clarence Blake, of Boston, U.S., on "Sound, in Relation to the Telephone," was read by the secretary. Its classical nature precludes the possibility of rendering a mere summary of it intelligible without the accompanying illustrations, which

we have not space to reproduce here. We hope, however, to give some account of it when reporting the discussion, which is promised for the next meeting.

A second paper, "On the Telephone Harp," was read by Mr. F. A. Gower, also of Boston, the inventor of the instrument, and was elucidated by some interesting experimental illustrations. This "Harp," which formed an object of great interest at the recent *conversazione* of the Royal Society, may be briefly described as follows:—

A series of steel tongues, similar to those of a large musical box, are firmly clamped at their base by a double bed-plate of steel. On the upper side of each tongue, and near the base, is soldered a small platinum spring, which shares the motion of the tongue and vibrates against a metal contact-pin. The journey performed by the platinum spring being so much less than that of the extremity of the tongue, a much finer adjustment is thus rendered possible, while the resilience of the spring prevents the vibrations from being so quickly damped as they would be if the tongue ends made the contacts. Another and lighter series of metal tongues, or "switch" springs, is ranged over the contact pins. The key-board is similar to that of a piano; and two electrodes are led from the instrument —one connected with the whole series of steel tongues, the second with the "switch" tongues.

On striking a key two operations are performed; firstly, a hammer like that of a piano is jerked up against the steel tongue, falling again immediately so as to leave the latter vibrating; and, secondly, the last part of the depression of the key presses the "switch" spring on the contact pin. When therefore, the electrodes are joined to the poles of a battery, a series of currents flow through the circuit, one for each vibration of the tongue; and if a telephone is inserted in the circuit, the diaphragm gives out a loud musical note corresponding to proper note of the tongue.

In the experiments performed by Mr. Gower before the Society, two or more distinct circuits were employed; the first comprised the "Harp," the battery (2 to 4 cells, Leclanché or bichromate), and the primary wire of an induction coil; the second included the secondary wire of the coil, and the telephone on the lecture table. A number of airs, skilfully performed upon the "Harp" by Mr. Higgs, Mr. Gower's musical assistant, were vividly reproduced by the telephones on the table, and also by others placed in different parts of the theatre.

One experiment was especially interesting; and for this, four circuits were employed. The first included "Harp," battery, primary of induction coil, and the coils of a "relay" telephone, these being all placed in a distant room. The second remained as before. The "relay" telephone was provided with a contact point, adjustable by a screw, and against which its diaphragm vibrated. This contact point and the diaphragm formed with a second battery, and the primary of a second induction coil, the third circuit; and the fourth consisted of the secondary of the second induction coil, and a Geissler tube. Music being now played upon the "Harp," currents from the first battery flowed as before through the first circuit; induced currents flowed the second circuit, reproducing the music in the telephones; currents caused by the make and break of the relay telephone flowed through the third circuit; and induced currents, from the second induction coil, flowed through the fourth (vacuum tube). Each note was therefore accompanied by an illumination of the Geissler tube.

Some useful lessons, Mr. Gower remarked, are deducible from these experiments, and are not at first sight reconcilable with each other. Thus, on the one hand, placing the finger upon the diaphragm of one of the telephones from which music was proceeding had no apparent effect: the music went on as before, even when the diaphragm was tightly pressed. This appeared to show that the effective vibrations were principally molecular. On the other hand, the "relay" telephone showed that, when free, the diaphragm oscillated sufficiently to make and break contact with a battery terminal.

These and other experiments shown by Mr. Gower were watched with much interest, and elicited frequent applause.

General Science Columns.

JULIUS ROBERT MAYER, the illustrious physicist, was born at Heilbronn, in Würtemburg, on November 25th, 1814. His name will be ever memorable in conjunction with that of Dr. Joule, of Manchester, as the father of the science of thermo-dynamics. Mayer pursued his medical studies first at Munich, then at Paris, and, afterwards, in 1840, proceeded to Batavia, in the island of Java, where he had occasion to bleed a native suffering from fever. He was struck with the vivid redness of the venous blood, as compared with that of Europeans, and came to the conclusion that it was due to the warmer climate rendering oxidation of the blood less necessary to maintain the animal heat. It was this accident which directed his mind to its future sphere of labour. He was led thereby to study the phenomena of animal heat and the far-reaching relations of heat and work done. He returned to Germany and became "City physician" at Heilbronn, doing good small work for Heilbronn, and greater work for the world. In 1842 he published his first paper, "On the Forces of Inorganic Nature," in Leibig's *Annalen der Chemie*, and attempted to prove the two great principles of the indestructibility of matter and the conservation of energy. Mayer's method of proof has been questioned of late chiefly by Professor Tait; but it must be admitted that Mayer did the best he could with the materials and opportunities at his disposal. It was reserved for Joule, by his series of classical experiments, extending from 1843 to 1849, to place on a firm and practical foundation of quantitative results the new principle of the conservation of energy, and, to demonstrate what Mayer had been the first to enunciate. Other essays on cognate subjects followed each other from Mayer's pen at intervals of a few years, including one on "Celestial Dynamics," which created a great deal of notice. These essays were re-printed in one volume, entitled, *Die Mechanik der Wärme*, in 1867. In "Celestial Dynamics" he propounded the well-known theory that the heat of the sun is maintained by the impact of countless meteorites on its disc, and that the zodiacal light is but the reflection of the sunlight on this dust of the inter-stellar space. Domestic affliction and public criticism for a time overthrew his reason, and he was confined in a madhouse; but after a few years he recovered his usual health, and peacefully cultivated his garden at Heilbronn, where he died on March 21st.

PROFESSOR TYNDALL ON SOUND-PRODUCERS (*continued*).—I have referred more than once to the train of echoes which accompanied the explosion of gun-cotton in free air, speaking of them as similar in all respects to those which were described for the first time in my report on fog-signals, addressed to the Corporation of Trinity House in 1874.* To these echoes I attached a fundamental significance. There was no visible reflecting service from which they could come. On some days, with hardly a cloud in the air, and hardly a ripple on the sea, they reached us with magical intensity. As far as the sense of hearing could judge, they came from the body of the air in front of the great trumpet which produced them. The trumpet blasts were five seconds in duration, but long before the blast had ceased the echoes struck in, adding their strength to the primitive note of the trumpet. After the blast had ended the echoes continued, retreating further and further from the point of observation, and finally dying away at great atmospheric distances. The echoes were perfectly continuous as long as the sea was clear of ships, "tapering" by imperceptible gradations to absolute silence. But when a ship happened to throw itself athwart the course of the sound, the echo from the broadside of the vessel was returned as a shock which rudely interrupted the continuity of the dying atmospheric music.

These echoes have been ascribed to reflection from the crests of the sea-waves. But this hypothesis is negatived by the fact that the echoes were produced in great intensity and duration when no waves existed—when the sea, in fact, was of glassy smoothness. It has been also shown that the direction of the echoes depended not on that of the waves, real or assumed, but on the direction of the axis of the trumpet. Causing that axis to traverse an arc of 210°, and the trumpet to sound at various points of the arc, the echoes were always, at all events in calm weather, returned from that portion of the atmosphere towards which the trumpet was directed. They could not, under the circumstances, come from the glassy sea; while both their variation of direction, and their perfectly continuous fall into silence, are irreconcileable with the notion that they came from fixed objects on the land. They came from that portion of the atmosphere into which the trumpet poured its maximum sound, and fell in intensity as the direct sound penetrated to greater atmospheric distances.

To attempt to interpret an experiment which I have not had an opportunity of repeating, is an operation of some risk; and it is not without a consciousness of this that I refer here to a result announced by Professor Joseph Henry which he considers adverse to the notion of aërial echoes. He took the trouble to point the trumpet of a syren towards the zenith, and found that when the syren was sounded no echo was returned. Now the reflecting surfaces which give rise to these echoes are for the most part due to differences of temperature between sea and air. If, through any cause, the air above be chilled, we have descending streams—if the air below be warmed, we have ascending streams as the initial cause of atmospheric flocculence. A sound proceeding vertically does not cross the streams, nor impinge upon the reflecting surfaces, as does a sound proceeding horizontally across them. Aërial echoes, therefore, will not accompany the vertical sound as they accompany the horizontal one. Professor Henry's experiment, as I interpret it, is not opposed to the theory of aërial echoes which I have ventured to enunciate. But, as I have indicated, not only to see, but to vary such an experiment, is a necessary prelude to grasping its full significance.

In a paper published in the "Philosophical Transactions" for 1876, Professor Osborne Reynolds refers to these echoes in the following terms: "Without attempting to explain the reverberations and echoes which have been observed, I will merely call attention to the fact that in no case have I heard any attending the reports of the rockets, although they seem to have been invariable with the guns and pistols. These facts suggest that the echoes are in some way connected with the direction given to the sound. They are caused by the voice, trumpets, and the syren, all of which give direction to the sound; but I am not aware that they have ever been observed in the case of a sound which has no direction of greatest intensity."

The reference to the voice and other references cause me to think that, in speaking of echoes, Professor Osborne Reynolds and myself are dealing with different phenomena. Be that as it may, the foregoing observations render it perfectly certain that the condition as to direction here laid down has nothing to do with the production of the echoes.

There is not a feature, moreover, connected with the aërial echoes which cannot be brought out by experiments in the laboratory. Standing on the deck of our steamer in front of the trumpet, at the South Foreland, on a day of acoustic flocculence, the sound failed to penetrate to any considerable distance. The open air of a room may be thrown into a condition which shall act in a precisely similar manner. Standing behind the trumpets, the sound which was refused transmission was sent back by reflection. With the open laboratory air, rendered purposely non-homogeneous, precisely the same effect is obtained. I have recently made the following experiment:—A rectangle, 22 inches by 12, is crossed by 23 brass tubes, each having a slit along it from which gas can issue. In this way, 23 low, flat flames are obtained. A sounding reed, fixed in a short tube, is placed at one end of the rectangle, and a sensitive flame at some distance beyond the other end. When the reed sounds, the flame in front of it is violently agitated, and roars boisterously. Turning on the gas, and lighting it as it issues from the slits, the air above the flames become so heterogeneous that the sensitive flame is instantly

* See also *Philosophical Transactions* for 1874, p. 183.

stilled by the aërial reflection, rising from a height of 6 inches to a height of 18 inches. Here we have the acoustic opacity of the air in front of the South Foreland strikingly imitated. Turning off the gas, and removing the sensitive flame to some distance behind the reed, it burns there tranquilly, though the reed may be sounding. Again, lighting the gas as it issues from the brass tubes, the sound reflected from the heterogeneous air throws the sensitive flame into violent agitation. Here we have imitated the aërial echoes heard when standing behind the syren-trumpets at the South Foreland. The experiment is extremely simple, and in the highest degree impressive.

Gases Dissolved in Sea-water.—Mr. J. Y. Buchanan, from observations made on board the *Challenger*, arrives at the conclusion that the absolute amount of oxygen and nitrogen contained in sea-water is less than that contained in river water; but the relative proportions of the two gases to each other is about the same in both kinds of water. He is also of opinion that the absolute amount of gas dissolved in sea-water depends on the temperature; and that water at a great depth has all the physical properties of surface water, although when brought to the surface from a great depth water parts with some of the gas contained in it, since small bubbles may be observed to cluster on the sides of the vessel holding it, if it be allowed to stand. Surface sea-water contains from 33 to 35 per cent. of its volume of oxygen, the former result being obtained from the region of the trade winds, the later from the Antartic circle. Up to depths of 1,800 feet the amount of oxygen decreases, and then increases. When the bottom is composed of diatomaceous mud or ooze, the superincumbent water contains most oxygen, and when of red-clay least oxygen. This fact seems to prove that its presence depends in some way on the prevalence of animal life.

Dredging.—During his recent trip to the Gulf of Mexico, Professor Agasziz made use of a steel rope 1¼ inch in diameter, for dredging, and found it in point of celerity and convenience, beyond comparison with a hemp rope. Thus in dredging a well or sounding operations, steel is taking the place of hemp.

Another New Explosive.—Professor Osborne Reynolds has discovered a new explosive, composed of seventy-five parts of chlorate of potassium to twenty-five parts of sulphurea. Sulphurea is a substance discovered by Professor Reynolds some years ago in the waste product of coal-gas. The two ingredients can be kept apart until required, and may therefore be safely transported. The new explosive is a white powder, which can be ignited at a lower temperature than gunpowder, and leaves less ash.

Improvements in Electric Gas-lighting.—The various appliances that are now so successfully employed in lighting gas-lamps in halls, theatres, and in the streets, usually aim only to furnish the spark or hot wire that will fire the gas. The supply of gas must be turned by hand or by some mechanical means, and thus a part of the work of gas-lighting must still be performed at a waste of time, labour, and gas. To obviate this, and to save the gas thrown away after it is turned on and before it is lighted, a new system of electric gas-lighting has been brought out that turns on the gas, and at the same time sets it on fire. The same apparatus will also shut off the gas and extinguish the light, and by attaching it to a clock it can be made to light and put out the lamps automatically at any hour at which the clock may be set. The apparatus consists of a small electro-magnet, designed to be placed on the gas-jet just over the gas-cock, and a vibrating armature, and platinum wire for lighting the gas. The gas cock is a two-way valve, and having a small ratchet wheel in the place of the usual handle. This wheel is placed on one side of the gas pipe, and the electro-magnet is put on the opposite side; between them is hung a rocking-bar, supported on pivots on the pipe; at one end of this bar is the armature of the magnet, and at the other end is a pawl, playing in the ratchet wheel; a spring is also added to give the bar a vibrating motion when the magnet is excited by the current from the line. When the circuit is made by the battery at the station, the rocking-bar vibrates, and by means of the pawl turns the wheel part way round, and thus lets on the gas. The same current that sets the bar in motion also inflames the gas at the same instant. The gas being turned on, an eccentric on the side of the well breaks the circuit, and the wheel stops, leaving the gas turned on. After all the lamps in the circuit have been lighted in turn, the circuit is broken, and everything remains as it is till it is again closed. This second closing of the circuit produces the same effect on each apparatus in turn, but with the reverse effect in the lamp, for the wheel is pulled round by the vibrating bar, and the gas is shut off and the lamps extinguished. This same arrangement may be attached to single lamps in the house by omitting the electro-magnet, and substituting a small chain, that may hang below the lamp. On pulling this chain by the hand the pawl plays in the ratchet-wheel and turns on the gas, and at the same time lifts the platinum wire into contact with the jet, and the resulting spark fires the gas. To shut off the gas the chain is pulled again, and in the same manner the wheel is carried part way round, and the gas is shut off. This apparatus is designed for lighting street lamps by a cable laid just under the pavement, and from lamp to lamp. Circuits of 200 street lamps may be turned on and lighted, and turned off in a few seconds from a central office or the police station, either by hand or by means of clock-work. By a simple arrangement the same cable may also be exposed at each lamp-post, so that the police on beat may communicate by telephone with the station.—*Scribner's Monthly.*

A CURIOUS COLUMN OF LIGHT.—At Logelbach, in Alsace, on March 23rd, just before sunrise at 7 a.m., a luminous column was seen, orange red, at the horizon, and fading into ashy red as it rose upward in the sky. Its height was from 25° to 35° of arc, and its breadth 2° to 2½°. It appeared to be based on the sun, which rose at 7 o'clock, of an indigo-red colour, and lifted the column with it. A few minutes later the column gradually disappeared from the top downwards.

City Notes.

Old Broad Street, May 14th, 1878.

IT is satisfactory to learn that the Brazilian Submarine Telegraph Company is now in smooth water again. On the 14th of last month their cable was broken close to the shore at Lisbon, through being hooked by the anchor of a ship. The chairman, very properly, took occasion, at the half-yearly meeting last week, to explain that the breakage was not owing, in any degree, to any defect in the cable; and though, thanks to the attention of the official of the Telegraph Construction and Maintenance Company, it was quickly and thoroughly repaired, the business of the concern was, of course, affected for a time. We are not sure, however, that the breakage was not a blessing in disguise: for we gather from Viscount Monck's speech of the other day that the receipts of the Company have increased by nearly £100 a day since the cable began working again, and £100 a day more means a large sum a year extra; so what will repairing the cable cost? Turning to quite another matter, the noble chairman told the shareholders at the meeting that the arrangement they made with the Western and Brazilian Company had been very unsatisfactory to the Company; we can readily understand that it has: for they had, he said, paid the Western Company very large sums of money, and received very little, if anything, in return. As we are also far from sanguine respecting the future of the Western and Brazilian Company, we agree with the intimation of Lord Monck that the arrangement should in the interest of the shareholders of the Brazilian Submarine Company be reconsidered at the earliest possible moment. A hint was given that the directors of the Western Company might not be willing to meet the directors of the Submarine Company in an amicable spirit; but, if the former are wise they will not run any risk of crippling their resources by expensive litigation. In any case, there is certainly no reason why the Brazilian Submarine Company should continue an arrangement which after a fair trial, has been found to be the reverse of advantageous to the shareholders. The report of the Brazilian Company was unanimously adopted.

At the seventh ordinary general meeting of the shareholders of the German Union Telegraph and Trust Company, a satisfactory report of the progress of the company was read and adopted without discussion. The total receipts for the year ending May 1st amounted to £12,293 7s. 6d., showing an increase over the previous year of £632 14s. 1d. The working expenses were £474, leaving a balance available for dividend of £11,759 7s. 2d. Most people will agree that after the amount of the working expenses had been mentioned there was no need for any discussion. A dividend of 6s. per share, making, with the *interim* dividend distributed in January, £5 17s. 6d. per cent. for the year, was agreed to and accordingly declared. The increase in the business of the company for the year, considering the smallness of the concern, is very great, the number of messages transmitted showing an increase of no less than 60 per cent. After the report had been adopted, a shareholder expressed his gratification that the company had got on so favourably, for, he remarked, "on first starting, matters were not so pleasant." Nor were they, as the chairman at once frankly admitted. But while it is not cheerful to make a bad beginning, it is better to have a bad beginning and a good continuation than *vice versa*, as is too often the case. It may reasonably be hoped that the shareholders of the German Union Company will have equal occasion for congratulating each other next year.

Possibly Mr. Abbott is waiting until next month, but, at any rate, the glowing reference we expected to see in his May circular to the West India and Panama Company is conspicuous by its absence. In fact, Mr. Abbott appears to have abandoned telegraph shares and gone in for railways, tramways, and, of all things in the world, hotel shares. The meeting of the company, which was held just too late for us to notice in the last number of the *Telegraphic Journal*, seems to have been of a satisfactory character. There was a time when the same remark could not, in any sense, be applied to the meetings of the West India and Panama Company. Then, the chairman referred to the fact, that for the first time in the history of the undertaking, the full amount of subsidies for the half year had been received, or was in course of payment. The reconstruction scheme has also been settled, and the liquidation process is at an end. We cannot say that the cost of the liquidation, namely £722, is extravagant. The West India and Panama Company has seen stirring times, and it is possible that the painful experience the shareholders have had to go through will warn them that their dividend can be materially influenced by good, or by bad, management.

It was but natural that the chairman of the Submarine Cables Trust should seize the opportunity offered him at the meeting of the company, to make a few complacent remarks on what he considers is the "success" achieved by the union of the Direct United State and Anglo-American Companies. Without qualifying by a word what we have over and over again urged respecting that amalgamation, we do not dispute that the Trust is begining to look up.

The secretary of the Direct United States Cable Company has given notice that the Board have resolved upon the payment of an *interim* dividend of five shillings per share, being at the rate of five per cent. per annum from the quarter ending March 31st. The dividend is payable after the 16th instant.

"In sympathy with the prevailing depression," writes one of the most enthusiastic believers in the "great future" of the Chatham and Dover Railway Company, "the price of the stocks of this railway remain at about the same level as they did last month." Yes; the anticipations of the gentlemen who made such a commotion at that Cannon Street meeting have still to be realised, even in part, and the South Eastern Company pursues the peaceful tenor of its way. Nor, although the new passenger steamer which the Chatham Company has just added to its fleet is a splendid boat—we regret to question whether at last "the attendant horrors of the Channel passage are completely overcome"—do we think that it will be the means of making the fortunes of the shareholders? This year will, of course, be an exceptionally good one.

The shareholders of the South Western Company are not persons to be envied at any time. It is possible that they may be envied less than ever shortly. For if the Board of Trade insists, as it ought to insist, upon the company raising the platforms of its stations, the outlay, which will be inevitable, may swamp the profits of the company.

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PROFESSOR HENRY.

PROFESSOR JOSEPH HENRY, who died at Washington, U.S.A., on May 13th, for many years occupied the position of Secretary to the Smithsonian Institution, but is far better known among electricians by his early original discoveries in electricity and magnetism, many of which were of the very highest practical importance. He was born at Albany in 1797, and had therefore completed his 80th year. His education was only such as the common schools and academy of his native city afforded; and like the lamented Faraday, who in many of his characteristics he greatly resembled, he was probably not a little indebted to that freedom from conventional modes of thought which is found in connexion with self-developed mental resources, for the striking originality which he often exhibited in carrying out his investigations and researches. In 1826, he was appointed to a Professorship in the Albany Academy, and in the following year he commenced that splendid series of investigations upon which his scientific reputation ultimately rested, and which extended through a series of twelve years. In 1831, Henry produced and exhibited the first electro-magnetic engine, which although very simple in its form, embodied for the first time, the principle of the pole-changing commutator. In the same year he published in the *American Journal of Science*, a paper on electro-magnetism, of the very highest practical importance. Up to that time, no advance had been made upon the form of electro-magnet devised by Sturgeon, consisting of a bar wound with a single layer of turns of thick wire, excited by a battery of large plates, and low projectile force; under such conditions the addition of even a few feet of wire materially lessened the magnetic force developed.

In view of this fact, Barlow, in 1824, had pronounced the idea of an electric telegraph chimerical. But in the paper alluded to, Henry demonstrated that by winding the magnet with many convolutions of wire, and by forming the battery of many pairs of elements connected in series, that a high degree of magnetic intensity could be produced through a long wire. This law, which to a modern electrician seems so simple and obvious, was first discovered and demonstrated by Professor Henry, and he was also quick to foresee its practical importance, for in the same paper, after describing his experiment in detail, he directed attention to the practicability of applying the intensity magnet as he termed it, to the transmission of intelligence at a distance.

In the same year (1831), he constructed and exhibited a contrivance for giving signals at a distance by electro-magnetism, which consisted of a permanent magnet upon a vertical axis, one pole of which was placed between the poles of a horse-shoe electro-magnet, while the other was arranged to strike against a bell. This was successfully operated through 8,000 feet of wire, in a room of the Albany Academy. There, in the presence of a class of students, was exhibited in operation, an instrument, which was actually a practicable electric telegraph. Had Henry elaborated and applied a telegraphic alphabet, there would have been little left for Morse to accomplish in order to have given to the world the sound-telegraph of to-day. But Henry stopped just short of that, leaving to his compeer the honours and the rewards of the invention of the commercial electro-magnetic telegraph of America.

In the same year Henry produced another striking illustration of the capacity of his improved electro-magnet. His papers in the *Journal of Science* having given him a high reputation, he was invited to perform a series of experiments at Yale College, New Haven. The invitation was accepted, and Henry's electro-magnet, constructed during that visit, and capable of sustaining a weight of 2,500 lbs., was for years one of the marvels of that Institution. A few weeks later he constructed another one capable of sustaining 3,600 lbs., and occupying less than a cubic foot of space, for the College of New Jersey.

In 1832 Henry made his second great discovery in electricity—the self-induction of secondary currents in a coiled conductor. In the same year he produced the electric spark by magneto-induction, a discovery made independently, and almost simultaneously, by Forbes of Edinburgh. Of these two discoveries, it should be said, in justice to the distinguished scientist who has just passed away, that they embrace all the essential principles of magneto-electricity to which so great a part of the life of Faraday was subsequently devoted, and to which his intellectual fertility gave such an important development.

It was impossible that an intellect of such a high order of ability should be permanently retained by the humble academy in which its earlier triumphs has been won. Jn 1832 the trustees of the College of New Jersey unanimously elected young Henry, Professor of Natural Philosophy, and he at once entered upon his duties. His very first course of lectures at Princeton included a demonstration of the feasibility of the electric telegraph with abundant experimental illustrations, but here again, he

stopped short of the apparently obvious, practical, realization of the system.

Having remained five years at Princeton, in 1837 he visited this country, where his brilliant reputation had already preceded him. While in London, he met Professor Wheatstone, to whom his researches were already familiar, and with whom he discussed his plans for producing not merely signals, but large mechanical effects at indefinitely extended distances, by means of the intensity magnet.

From this time, Professor Henry seems to have remained in comparative retirement, until in 1876, upon the orginization of the Smithsonian Institute, at Washington, he was elected its Secretary, a position which he continued to fill until his death. In 1849 he was also elected President of the American Association for the Advancement of Science, and in 1868 he became President of the National Academy of Sciences, at the last meeting of which he presided. In 1871 he was placed at the head of the Lighthouse Board of the United States, in which capacity his services have been of the greatest value to the Government of the United States.

The literary work of Professor Henry, is scattered through nearly all of the leading American scientific periodicals. In 1869, he published in book form, his collected papers up to that date, under the title of "*Contributions to Electricity and Magnetism.*"

Professor Henry, left a wife and three daughters, and although he saved but little money during his long service in the Institution, yet by the generosity of his friends, the family are well provided for. His funeral took place on the 17th, at Oak Hill Cemetery, in Washington.

FRANK L. POPE.

TELEGRAPHIC INVENTION IN ENGLAND AND AMERICA.

EVER since the Centennial Exhibition of 1875, America has taken a pre-eminent position among the nations for invention. There she displayed to the world the fruits of her practical ingenuity, her rich material resources, and mechanical skill. Europe was not unacquainted with the efforts of American inventive genius before the great Fair took place. Far from it. A generation which has been born to the sound of American clocks, and suckled on American feeding-bottles, is not likely to be ignorant on this head. The Americans have always been distinguished for their inventiveness; but the Centennial Exhibition showed their characteristic ability in its true greatness. We knew that the national fertility in patent cow-milkers, apple-parers, and other Yankee notions was unrivalled, that the crop of "five dollar ideas" was inexhaustible; but the Exhibition brought us face to face with the really great inventions of America. In no department of invention have the Americans figured more prominently than in that of telegraphic instruments, and no section of the Exhibition was so brilliant as this in evidences of their achievements. The telephones of Gray and Bell, the automatic and quadruplex instruments of Edison, especially created an interest which spread their fame far and wide. Since then, the phonograph of Edison, following hard behind the speaking telephone, has greatly helped to extend and confirm the national reputation. It may be said that the present time is only a happy conjuncture for America, that the telephone and phonograph may prove to be more dazzling than useful, and that she is fortunate in producing just now a cluster of extraordinary inventors. But we think, on studying the subject closely, that the eminence of America in the invention of telegraph appliances is undoubted. Behind her splendid constellation of great inventors, she can boast a thousand lesser lights; and besides the telephone and phonograph it will be found that she possesses a great variety of important and novel instruments.

But though America has been shooting into note, and engaging the attention of the world, England and other European countries have not been idle. They have been working diligently in other fields; and especially in that of pure science. In pure science. America has done little hitherto, perhaps for the reason that it does not pay to discover principles. There are no dollars in an abstract law. English electricians, as we pointed out in a recent article, although they have produced no striking results lately, have been steadily working. They have been extending the boundaries of the science itself, and in invention they have been engaged in advancing railway and submarine telegraphy. The siphon recorder, the curb-sender, and the application of the duplex system to submarine cables, are first-class inventions, yet in the field of land-line signalling apparatus England must be said to have been exceptionally barren of late years. In this domain we must at present yield the palm to America.

Having admitted this much, we naturally ask why it is so. With the mechanical results of the Victorian epoch around us, and in remembrance of the great inventors who have recently passed away, or who are still in our midst, we cannot allow that it is in point of inventive genius that we are lacking; but if the genius be granted, the environment must be at fault. In America, keen competition among telegraph companies, an immense area of country and mileage of lines, a cheap patent system, and a

ready means of publicity, all tend to foster invention. In England, an exclusive Government system of telegraphs, and very onerous conditions of patent right, tend to damp invention in this direction. The importance of the patent law as a factor in this repressing influence was first pointed out by Sir William Thomson, after his return from the Centennial Exhibition; and that of the Government postal telegraph system by Dr. C. W. Siemens in his opening address to the Society of Telegraph Engineers this session. The effect of a rigorous patent law in checking invention is well seen in the case of Germany, a country which produces very few inventions. Professor Bell himself is an example of an inventive Englishman finding more favouring circumstances for his powers in America than at home. Varley's 1870 telephone patent contained the roots, and more than the roots, of Gray and La Cour's recent tone telephones; but it remains a patent still. The conditions for its practical development were not genial in England, and the invention was still born.

Having found what appear to be the true causes of the admitted evil, we now turn to seek a remedy for it. The new patent law before Parliament may be expected to do good to invention in general, and, therefore, also to telegraphic invention; but it appears to us that a special remedy might be found in the Government telegraph system. If greater facilities were given for testing new inventions, and if handsome premiums were given for successful ones, and inventions openly invited and welcomed, we think that telegraphic invention could not but be stimulated again in this country, and that something of the old activity which existed in the days of the rival companies might be brought back.

THE ELECTRIC LIGHT IN PARIS.

TRAVELLERS arriving by night from London at the Gare St. Lazare cannot fail to remark the brilliant series of electric lights which illuminate the whole covered area of that railway station, and to note the striking contrast between the pure white electric and the dull yellow gaslights surrounding them. But the greater incomparable superiority of the former over the latter is best seen at the Place de l'Opera, where the great lamps are fitted up with Jablochkoff's electric candle. Across the open area of the place, and extending towards the new Avenue de l'Opera, there is a double row of large lamp posts down each side, each surmounted by a large cylindrical lamp of clouded glass and containing 12 electric candles. These are burning every night, and serve to light up the whole space to a clearness which permit the different tints of the ladies' costumes to be easily distinguished. On opera nights the two ornamental lamp posts fronting the façade of the Opera House have each three upper globes lit by the candle. These globes are of opal glass, and give a peculiar softness and silvery lustre to the light, which resembles that of the moon. They light up the centre façade, showing in relief the rich marbles, statues, and gilding. The ordinary globes of gaslights along the balconies of the building, together with these electric lights, have a rich effect, similar to a mixture of silver and gold in jewelry. The wide flight of steps leading up to the doors are illuminated almost like noon, and it is curious to see the gnats dancing about the white globes as if they believed it to be daylight. The electricity is supplied by a Gramme machine especially constructed to yield intermittent currents, and fed by another Gramme of the ordinary kind. It is led by cores under the pavement up the side of the lamp post to the candles. The cores have had to be protected, it is said, from ill usage, because attempts were made by agents of the gas companies to interfere with them. As soon as a candle burns down another is moved by mechanism into its place without much appreciable disturbance of the general effect. The light is remarkably soft and steady, and there is no flickering to speak of. These lights are Jablockhoff's advanced guard, and we may soon expect to hear of their being extended down the whole length of the Avenue de l'Opera and the boulevards themselves. They have only to be seen to be admired, and when once the public have grown accustomed to their superior excellence over gas, they will before long require an extension of the system. It is stated that M. Jablockhoff has received orders from the Municipality of Paris to introduce his light into sixteen other places in the city. A company is formed, and money is flowing in to support it. The only important drawback to the light is its costliness, for it is at present quite as expensive as gas.

The success of Jablockhoff is stimulating other inventors in this field. The lights of the Gare St. Lazare are produced by Lontin's distributing machines. The wicks are the ordinary prepared carbon sticks, regulated by Lontin's burner. They burn in the open air without globes or shades of any kind, and they are also remarkably steady. A drawback to their use is the hissing noise which they make, Jablockhoff's candle, being practically noiseless; but for public works this is of no consequence, and its comparative cheapness, renders this system very well suited for private establishments such as large workshops, railway stations, &c. It is said that the Company of the West, by employing this light at the Gare St. Lazare saves over £1,000 a year on lost or damaged goods which formerly were either stolen in the night or allowed to spoil.

Another light worth mentioning is that of a young inventor, named Emile Reynier. This system has been patented in England, and described in the *Telegraphic Journal* for Feb. 1st, 1878. His wicks are discs of carbon posed against each other, and slowly rotating by clockwork so as to bring fresh carbon surface always forward. The larger form of apparatus answers very well, and it has the merit of cheapness. M. Reynier has recently produced a small carbon light for domestic purposes. We were present at a public exhibition of it on Monday evening, May 20, at his atelier, but the apparatus was unfortunately not quite complete, and the light flickered every now and again in a way which will

have to be corrected before it will serve for any such purpose. The wick consisted of a small vertical disc of carbon slowly rotated by clockwork, with a rod of carbon no thicker than a wax taper, pointed vertically downwards to it. The current passed between the point of this rod and the edge of the disc, which by its rotary motion continually brought fresh carbon surface forward.

There are several trials of different electric lights arranged for during this season. M. Jablockhoff has a special annexe fitted up for exhibiting his light at the Exhibition. *It is said* in Paris that M. Gramme has now produced a modification of his Dynamo machine which is superior to that of Siemens.

CARPENTER AND MARTIN'S ELECTRIC CLOCK.

IN all the electric clocks hitherto invented, the action of the electric current has either been to control the movements of the works, or to actuate them by successive impulses given direct to the pendulum, or to a ratchet wheel in connection with the works, the pendulum being dispensed with. Messrs. Carpenter and Martin have gone a step further than this, and have, by combining the two latter actions, produced a novel form of clock.

The invention consists in fitting to the back plate A, fig. 1, of the clock or other time keeper, an electro-magnet B, B, which can attract an armature D; this armature has on it a push pawl E to engage into the teeth of a ratchet wheel F to cause the wheel to travel intermittently and wind up a spring G, one end of which is attached to the axle H and the other end to the "scape" or other wheel I, as in the detached view, Fig. 2, upon the teeth of which the pallet acts in the ordinary manner for maintaining the-to-and-fro motion of the pendulum J, which travels over the usual arc of a circle in proper order for the divisions of time. The pendulum aperture in which the crutch pin works is insulated by ebonite or other body K on one side, and it, with the other, which is in contact by a wire L from the coils, constitute the make and break action at each vibration of the pendulum. The other conducting wire M of the coils is connected with the back plate A or some other part of the clock, as found convenient. It is evident a clock as above described can by an attachment on the armature be put in connection with coils of other clocks or indicators of time at a distance that they can be regulated by the clock above mentioned.

Fig. 3 is a modification of the foregoing, in which the armature D is connected to a horizontal bar D[1], which terminates in a push pawl E, the horizontal bar being supported on a pivot or centre *a* by a strap N which is attached to the back plate A. The bar D[1] hangs and rocks upon this centre under the action of the battery in one direction, and under the action of a spiral spring *b* in the other, the limit of motion being regulated by set screws *c*, *c*. The pawl E pushes its wheel, which is an additional wheel F, upon the arbor of the centre wheel, and therefore travels with it. On the armature bar D[1] is a spring *d* having a loose detent, the point or tooth of which is in contact with one of the teeth of the fixed wheel F[1] and moves in the same direction along with it under the falling or descending motion of the armature bar through the tension of the spiral spring *b*; the drop of the bar causes the pin *e* to press down the fork M by acting upon its leg *f* to cause the wire *g* to dip into mercury contained in a basin *h* for the opening or completion of the electric circuit, which then instantly acts upon the magnets to draw the armature D down and its pawl end up, which end then acts upon the wheel F and winds up the spring G, the winding being in proportion to the unwinding, and is taken up the moment it has given it off. The lower part of the boss of the forked lever has a lip *i* upon it to take on to either side of a bent portion of a spring *k*, by which the fork can be retained for the time until overcome by the superior power of the spiral spring in one movement and of the armature by the current in the other. The spring when wound up has sufficient power or tension put into it to keep the works and hands going for, say two minutes, but as the additional wheel makes the movement of one tooth only corresponding to one minute of time, the spring has always the requisite power within it. One of the wires *l* of the magnetic coils B is always in the bath, as shown, and the circuit made by the dip of the wire *g* causes the armature to be depressed, and its opposite end with its pawl to be raised to push the wheels F on one tooth to wind up the spring again. The up rising of the pawl end causes the pin *e* to strike against the fork leg *m* to lift and carry the lip *i* over the bend of the spring *k*, to be there held until the next minute of time is completed, when the same action takes place. R is the stop pawl to prevent the spring and wheel returning, and to ensure its movement of rotation in one direction only.

Fig. 4 shows another arrangement by which a spring or weight can be wound up by an electric current, the works then being kept going by the spring like an ordinary clock having a pendulum or balance. In this view the armatures D, D, are double on separate bars D[1], D[1], and are attracted to distinct magnetic coils B, B, arranged on opposite sides of the back plate A, and drop simultaneously into contact on the completion of the current or circuit by the dip of the wire *g* into the bath *h*, as before explained. The inner end of one of these bars has a push pawl E to engage into the loose wheel F, and the other a slip pawl E[1] to engage into the fixed wheel, the two bars being connected that they may move together. The slip pawl follows the travel of the tooth in which it is engaged, and its weight assists the travel until it arrives at the end of the distance, when the loose pawl is acted upon again by the attraction of the armatures. The stop pawl R in this arrangement is centred upon a point *n*, and as its tooth rises up and over the teeth of the wheel in succession its tail end *p* drops and throws a hook *q* into the path and under a stud *r* projecting from a bar *s* to which the dip wire *g* is connected, the bar being part of the forked lever M[1], whose legs *f*, *m*, are acted upon by a pin *e*, as before explained, and is held in both the up and down positions by a lip or pin *i* acting upon the bent portion of the spring *k*. When the tooth of the stop pawl falls into the next tooth of the wheel its tail end rises, and the hook *q* lifts the fork by its leg *m* to take the wire *g* out of the bath to break the electrical circuit.

Fig. 4

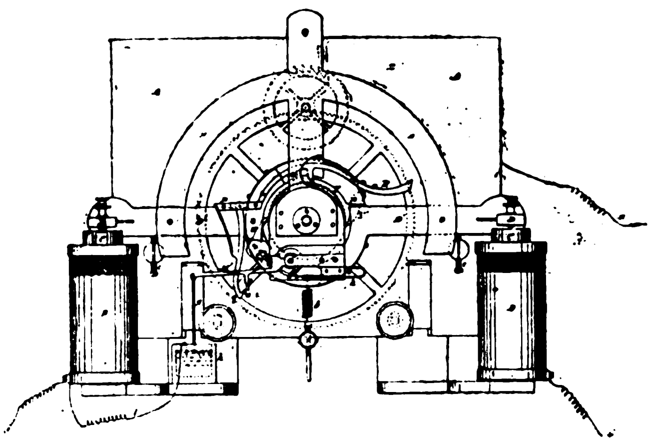
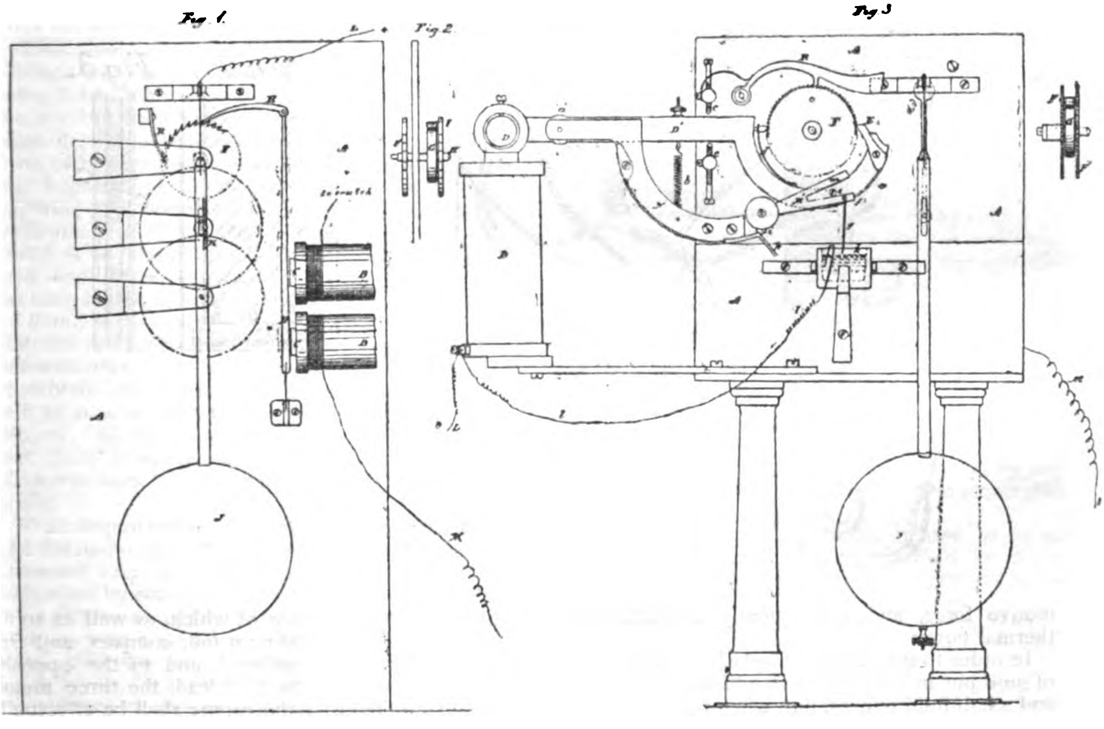


Fig. 1. Fig. 2 Fig. 3



THE BYRNE GALVANIC BATTERY.

By John Byrne, M.D.

THE accompanying figure will serve to give a correct notion of the general appearance of the battery.

A A, conducting cords; C, suspension rod and set screw combined, to connect between second and third cells in series; *a a*, poles of battery; *b b*, two set screws to couple for quantity; *d*, an extra binding post, not essential, but convenient when two cells only of the battery are required; *e e*, air tubes.

The composition of the fluid is one measure of commercial sulphuric acid to five of water, and to each pint of such dilution two ounces of bichromate of potash, though chromate of calcium, if substituted for the potash salt, will give a much higher electromotive force, and, consequently, a much greater thermal power.

In order to guard against splashing, the quantity of fluid put into each cell should not exceed seven and a half fluid ounces, but, when the zincs become thin from use, eight ounces may be accommodated.

To connect the battery for intensity, turn down C firmly and raise *b b*; and for quantity, reverse the operation by turning down *b b* firmly and releasing C from its contact with the lower metallic connection.

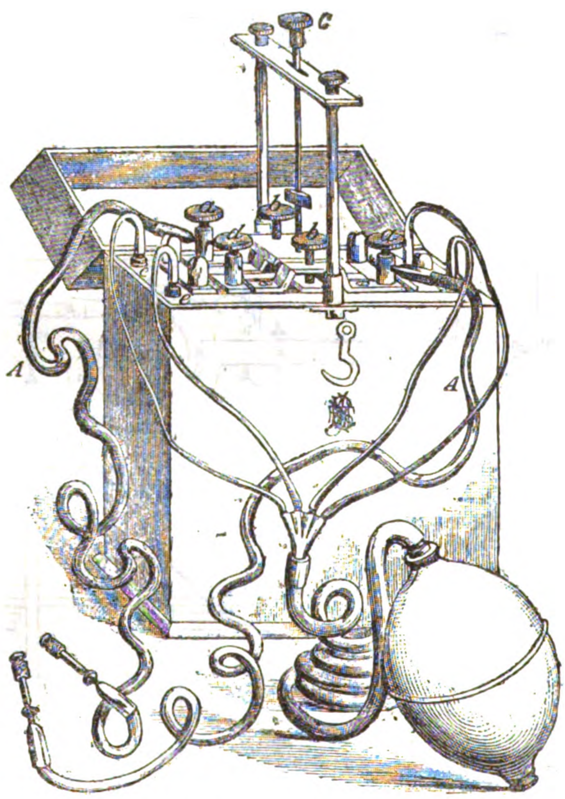
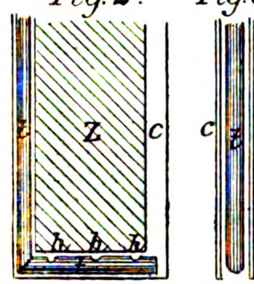


Fig. 2. Fig. 3.



In galvano-cautery, the main purpose for which, this little battery was first devised, and is now being extensively used, and more particularly during certain difficult and complicated surgical operations, this simple means of changing the entire character of the current to meet emergencies is of the utmost importance.

For obvious reasons, the pneumatic agitator should be worked by quick and short impulses, and not by slow or prolonged compression of the bulb, and the battery should not be kept immersed except when in action.

Finally, and in order that the aim contemplated in devising this voltaic organization, the lessening of internal resistance, may be correctly understood, I shall indicate, in a few words, the manner of preparing my patent negative plates, the distinctive feature of the battery, and the main source of its great power.

Each negative element consists of a plate of copper, to one surface of which, as well as to its edges, a sheet of platinum foil, compact, and free from pin holes, is soldered, and to the opposite surface or back a sheet of lead, the three metals being so united that the copper shall be effectually protected from the action of acids. The lead back and edges are then coated with asphaltum varnish, acid-proof cement, or any other like substance; and, lastly, the platinum face, being first rubbed over gently with emery paper, is to be thoroughly platinized in the usual manner.

Each cell of the battery above described contains two such plates, between which a single zinc is suspended, and when the elements are immersed so that the exciting fluid reaches within an inch of the top, a negative surface of 20 square inches is brought into action. It will thus be seen that the platinum alone is the negative metal, and the copper core a conducting body merely, while the lead, being almost passive, serves no other purpose than to protect the copper, so that any other, and, best of all, a non-metallic, substance capable of resisting the action of bichromate solutions, might, with advantage, be substituted for the lead.

By this device the fixed and well known electro-motive energy of a platinum-zinc pair, which, I need hardly say, is much higher than that of platinised silver, and, combined therewith, the conductivity of copper, are insured in one and the same compound element. As might be supposed, therefore, the practical result is that the only internal resistance to be encountered is that of the fluid, which, in the apparatus under consideration, must necessarily be quite small, since the zinc and platinum surfaces are no more than three sixteenths of an inch apart. As to the electro-motive force in bichromate fluid, repeated and carefully conducted tests, by General H. L. Abbot, U.S.A., and others, prove this to be from 1·95 to 1·99 volts. Now, as this battery will show, during agitation, on a tangent galvanometer, with no external resistance, a deflection of 82°, or nearly 50 webers, it follows that the internal resistance cannot be much over 0·04 of an ohm.

This, then, is the basis of what has been justly claimed for and accorded my battery, namely, "a remarkably high electro-motive force, with an immeasurably small internal resistance." Nor is this most desirable condition limited to the particular form of battery herein described, for these conducting negative plates have proved to be infinitely superior to carbon in a porous cup with concentrated bichromate of potash and sulphuric acid. As compared with platinized silver, also, with sulphuric acid and water, say one to ten or eleven, as an exciting liquid, not only will the electro-motive force be found to be twenty-five per cent. or more higher and the resistance less, but, there being no internal currents due to a platinum-silver pair, and comparatively little tendency to polarization, the action will be steadier than that of the most perfect Smee battery. Hence these plates are admirably adapted, and have been successfully tried, for operating electro-motors, for electro-plating, and other purposes.

With regard to the heating capacity of my battery, and the *modus operandi* by which pneumatic agitation increases its power, I have but a few words to add, suggested by reading the report of what took place at its exhibition in London.

It has been stated that "ten of my cells heated a stout platinum wire, thirty inches long and No. 14 B. W. G., to a glowing heat on pumping," and as evidence of the surprise created by this demonstration, the report goes on to say that "some idea will be formed of the great heating power here displayed, when it is remembered that it takes seventy or eighty Grove's elements to heat a similar length of No. 18 or 24 B. W. G. platinum wire." Now, inasmuch as I have often shown that four of these cells will heat to an equal degree from fifteen to eighteen inches of such wire, ten cells ought to, and would, I know, bring to a like condition considerably more than thirty inches. I am disposed, therefore, to surmise that the amount of this thick wire within reach at the time may probably have been limited to thirty inches, or there must have been some imperfection in the plates or cells used. At all events, the little battery of four cells will heat to a bright cherry-red twenty inches of No. 16 platinum wire.

As to the "development of heat within the cells," and "why the pumping of air into the cells should increase its current strength so much," it seems to me the distinguished electricians who are reported to have been present at this exhibition will, after a little reflection, find no difficulty in settling both questions to their entire satisfaction. I may state, however, that if a plate of amalgamated zinc, say $2\frac{1}{2} \times 5$ inches, and three-sixteenths thick, be immersed, *alone*, in 8 fluid ounces of strong bichromate fluid, the temperature of said fluid will rise to nearly 140° F. in about half an hour, or within a few degrees of the highest point reached during prolonged electro-chemical action and agitation. Whether the slight retardation of the current by the fluid may add a fraction to the heat produced by chemical decomposition, I am not prepared to say; but it is quite certain that the development of heat within the cell is due in a great measure, if not entirely, to chemical action of the fluid on the zinc, and this is one among other reasons why the plan of suspending one zinc between two negative surfaces has been adopted.

Where cells have been employed to operate electro-magnetic motors, however, and the exciting fluid has been sulphuric acid and water merely, I prefer to use a single negative surface and one zinc. In this case there is little or no chemical action on the zinc, beyond what is represented in current, and the energetic disengagement of hydrogen insures a free circulation in the liquid.

With regard to the method adopted for agitating the fluid, I have only to say that, after many experiments and trials with various other contrivances, this has been found the most simple and convenient. That agitation has no influence whatever on the electro-motive force of the battery is unquestionably true, as Mr. Preece has demonstrated, nor has it much, if anything, to do in the production of heat within the cells. In fact, its action is purely mechanical, and agitation by any other device, if equally practicable, would accomplish the same result.

The suggestion of Professor Adams, as to its effecting a free circulation in the fluid, by which the metallic surfaces are kept constantly clear, or, to use a meaningless term, *depolarized*, is, undoubtedly, a hint in the right direction, and in entire conformity with my own views.—*Scientific American*.

Figs 2 and 3 show the arrangement of the plates and air-tube in a cell of the Byrne battery.

In Fig. 3 the two compound plates *c c* are shown, between which the zinc plate is placed. This latter is indicated by *z* in Fig. 2, one of the compound plates being removed: *t t* is the air-tube of ebonite, the lower bend of which has small holes *h h h* perforated in it through which the air is blown.

BYRNE'S PNEUMATIC BATTERY.

By F. HIGGINS.

AMONGST the recently introduced electrical novelties from the United States, not the least remarkable, is the Byrne Pneumatic Battery, which for its size, gives many times the volume of current which has hitherto been obtainable from the most powerful of batteries.

Its construction has been already described; the plates are platinum and zinc in a solution of chromic acid, &c.

The plates have an active surface of 55 square inches each, and are distant $\frac{7}{8}$ in. from each other.

The behaviour of chromic acid as an electro negative element in a battery has not hitherto been satisfactory when employed for the production of a great quantity of current for any length of time, in consequence of the want of diffusibility of the reduced chromic oxide, which is formed in contact with the negative plate. Various mechanical means have been proposed for overcoming this difficulty, such as the circulating battery of Le Chuteaux, in which the cells are placed one above the other in a succession of steps and an excess of liquid from a reservoir flows by gravitation constantly through the series.

But though such systems are valuable for telegraph purposes, they are not suitable for the production of electric light or other electric heating effects of a current active in an exterior conductor of less or but little greater resistance than that of the generator.

The battery under consideration, appears to be especially suitable for the production of electricity in great volume for a length of time, dependent upon the capacity of the cells employed.

The action of the air, which is pumped through the cells, is, to remove and replace by fresh, the exhausted solution in the vicinity of the platinum plate; thus causing more rapid absorption of the hydrogen evolved, and at the same time increasing the local and other action upon the zinc plate.

It has been suggested that a combination of the oxygen of the air with the evolved hydrogen takes place; but this is disproved by the fact that precisely similar effects are obtained when coal gas is forced through the solution.

The function of the compound backing of copper and lead to the platinum plate, appears to be to increase its conductibility, and also to stiffen it and render it more convenient for employment.

The internal resistance is only 0·024 ohms, and the electro-motive force varies from 1·49 to 1·56 volts per cell.

The electro-motive force increases 1·89 per cent. shortly after immersion, while the battery remains inactive, but decreases upon air being pumped in. The cause of this appears to be the formation of a more electro positive solution in the neighbourhood of the zinc plate, when the battery is either standing undisturbed, or when the zinc is being rapidly dissolved in action. In order to test the correctness of this view, the zinc element was placed in a separate cell, and it was then found that the potential increased as the solution became charged with zinc.

Observation of the platinum plate under these circumstances, shewed that when the battery was short circuited for a few seconds, a dense cloud of chromic oxide accumulated upon its surface; this oxide was not easily dislodged by moving the plate about, but was readily dispersed by an upward current of air bubbles. The potential of the battery increased with its removal; in this respect, therefore, the action of the current of air resembles that of the nitrous acid gas given off from the negative plate of the Grove's battery when the current is active.

A considerable difference exists beteen the nature of the accumulated oxide upon a carbon and a platinum plate, the pores of the former becomes filled with an obstinately adherent mass of oxide, which is thus sheltered from the action of the current of air and liquid.

For example, in a carbon battery with plates of equal surface, the carbon plate acquired a negative potential equal to ·435 volts after having been short circuited for one minute (as compared with a similar plate of clean carbon in the same solution).

This negative polarity decreased to ·084 volts in 5 minutes, but the same diminution occurs with a platinum plate in about half the time.

When bichromate batteries are employed in telegraphy, no inconvenience is experienced from polarisation of the carbon plate when 1 square inch of surface is allowed for ·015 webers of current, and it is not essential that this surface face the zinc.

The back and front of a carbon plate are usually of different potentials when anything approaching to the full force of the battery is being utilised, but equilibrium is rapidly restored during the intervals of rest.

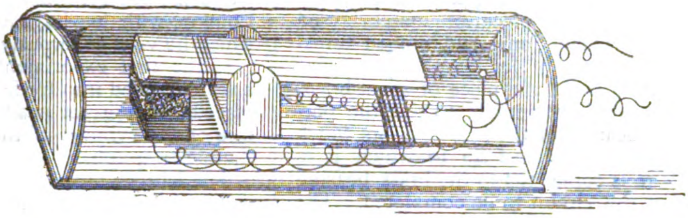
The solution used in the Byrne's battery is a powerful oxidant, and forms chromate of mercury when in contact with that metal, therefore amalgamation of the zinc plate does not protect it from solution, by the sulphuric acid present. The chromate of mercury is replaced by that of zinc, and the sulphuric acid displaces the chromic oxide, which then combines with the sulphate of potash to form chrome alum.

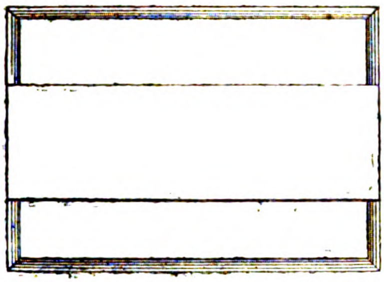
The continuous destruction of zinc, and consequent reduction of the solution prevents the application of this battery to other than temporary purposes, but there are many cases in which it may be employed with advantage as a convenient and abundant source of electricity.

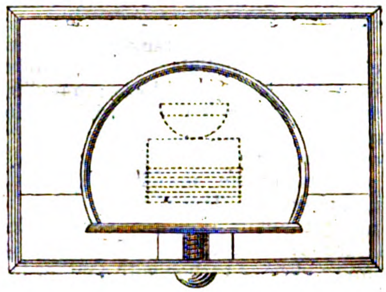
An idea of the enormous quantity of current which this battery can furnish may be obtained from the fact that each cell is equal to from 8 to 10 quart size Grove's batteries connected up quantitively.

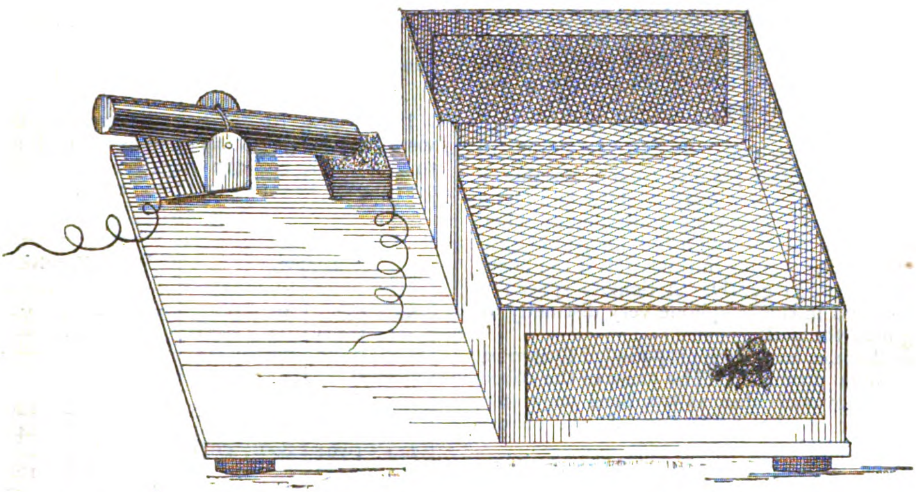
THE MICROPHONE.

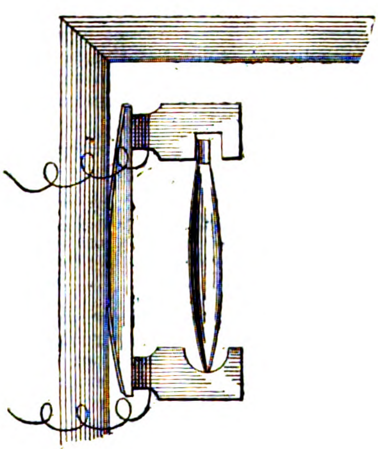
WE are enabled, through the kindness of Professor Hughes, to give in the present No. of the *Journal* some illustrations of the various forms in which he has constructed his "microphone." Fig. 1 consists of a short length of a child's wooden pen-and-pencil holder, a portion of the side being cut away and a flat piece of wood fixed to it; this forms a small box in which is fixed a small square piece of pine charcoal impregnated with mercury; around this a fine wire connection is twisted. A second square piece of charcoal is laid on the first piece, as shown

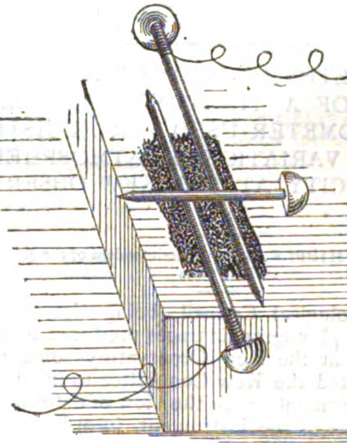












in the fig., the whole forming a kind of anvil. Resting on the latter is a piece of mercurialised charcoal, about 1½ inches long, and hinged transversely near the centre of its length by an axis turning in a bearing made of a piece of sheet brass. This piece of brass is bent double, so that the portion forming the bearing of the axis does not touch the surface of the wooden base to which it is secured. A wire is connected to the brass bearing so as to enable the circuit to be completed. The wooden case is placed inside a small square box, and is secured to the bottom of the latter, as shown by Figs. 2 and 3.

Fig. 4 shows the apparatus arranged for making the movements of a fly audible. The feet of the base-board are small india-rubber blocks; the cylinder is of gas carbon, and the anvil of mercurialised blowpipe charcoal.

Fig. 5 is a very sensitive form of microphone; it essentially consists of an upright, cigar-shaped piece of gas carbon, the lower end pointed and resting on a slight hollow formed on a small block, also of gas carbon. The upper end of the cigar rests on a similar piece of carbon with a rather large hole drilled in it. The carbon blocks are secured to a small piece of wood, which in turn is secured to the frame of an ordinary tracing slate, the frame itself having its wooden back fixed to it, and mounted on a wooden base, as shown. Wires lead away in all cases to an ordinary Bell telephone, and a few cells of any form of battery.

Fig. 6 shows the very simple, but at the same time efficient, microphone. It consists simply of two French nails fixed parallel to one another, a short distance apart, on a board, a third nail being laid across the two. This simple instrument, when connected with a battery and a Bell telephone, produces very audible sounds in the latter, if the board be touched ever so gently. Articulate speech is also reproduced in the telephone very distinctly on speaking near the nails.

Various theories have been propounded to account for the results produced. The cause of the effects seem almost obviously due, as has been suggested, to a variation in the perfection of the contact between the touching surfaces.

[We shall be pleased to receive correspondence from our readers on the subject of their experiments with the Microphone.—EDIT. TEL. JOUR.]

ON THE DETERMINATION OF THE SCALE VALUE OF A THOMSON'S QUADRANT ELECTROMETER USED FOR REGISTERING THE VARIATIONS IN ATMOSPHERIC ELECTRICITY AT THE KEW OBSERVATORY.

By G. M. WHIPPLE, B.Sc., Superintendent of the Kew Observatory.

THE Meteorological Council, being desirous of analysing the photographic traces produced by their electrograph at the Kew Observatory some time since, requested the Kew Committee to institute a series of experiments, with the view of determining the scale value of the instrument, in order to prepare a suitable scale for measuring the curves.

The experiments were all made in Dr. De La Rue's laboratory, Charlotte Street, Portland Place, London, with his large chloride of silver battery, which he very generously placed at my disposal.

In the first experiment readings were taken on a scale divided into fortieths of an inch, which was placed in the exact position occupied by the front face of the cylinder of the registering apparatus of the electrograph.

The battery terminals were then attached to the electrodes of the instrument, and the cells joined up in series as required. The deflections produced by the different potentials were read off on the scale with the following results, the quadrants being put to earth at the beginning of each experiment with the view of obtaining a correct value of the zero.

In experiment 1, only the potential of the positive pole was measured.

EXPERIMENT 1.

No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.
0	0·000	200	1·762	440	3·300	680	4·275
20	0·200	240	2·050	480	3·487	720	4·362
40	0·400	280	2·375	520	3·637	760	4·425
80	0·900	320	2·650	560	3·812	800	4·500
120	1·112	360	2·887	600	3·950		
160	1·450	400	3·100	640	4·087		

In the next experiment the positive deflections were read for potentials increasing by hundreds up to 800 cells, and the negative for potentials increasing by twenties up to 200 cells.

EXPERIMENT 2.

Positive.				Negative.			
No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.
0	0·000	600	3·725	0	0·000	120	1·200
100	0·900	700	3·951	20	0·125	140	1·450
200	1·701	800	4·051	40	0·287	160	1·575
300	2·387			60	0·525	180	1·850
400	2·951			80	0·725	200	2·100
500	3·401			100	0·975		

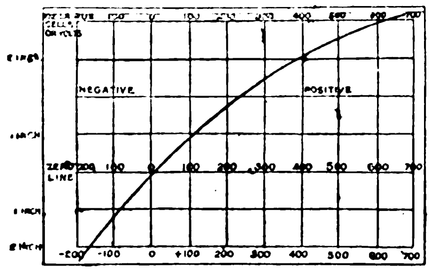
The negative deflections in the next experiment were obtained for potentials diminishing from 200 cells. The positive again increased by hundreds.

EXPERIMENT 3.

Positive.				Negative.			
No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.
0	0·000	600	3·750	200	2·250	80	0·825
100	0·950	700	3·975	180	2·000	60	0·612
200	1·750	800	4·100	160	1·725	40	0·400
300	2·400			140	1·512	20	0·200
400	2·950			120	1·287	0	0·000
500	3·450			100	1·000		

The scale was then dismounted, and a frame substituted for it containing a sensitised sheet of paper (such as is used in the self-registering photographic instrument at Kew) and having a sliding shutter.

The image of the illuminated slit reflected from the mirror of the electrometer, falling on this paper, made a photographic impression of each deflection of the needle with various numbers of cells in circuit. The time of exposure of the paper was two minutes.



After the sheets had been developed and fixed, the deflections were measured with a tabulating instrument, and the following results obtained:

EXPERIMENT 4. EXPERIMENT 5.

Positive. (Exp. 4)		Negative. (Exp. 4)		Positive. (Exp. 5)		Negative. (Exp. 5)	
No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches,	No. of Cells.	Deflection in inches.
0	0·000	0	0·000	0	0·000	0	0·000
100	0·949	40	0·410	100	0·918	40	0·410
200	1·764	80	0·880	200	1·725	100	1·135
300	2·412	120	1·323	300	2·406	160	1·701
400	3·013	860	1·805	400	3·003		
500	3·452			500	3·454		
600	3·806			600	3·784		
700	4·049			700	4·052		

After these experiments the quadrants were put to earth, and the instrument left until the following morning, when observations were again made of a similar nature.

It was, however, observed that the deflections noted were found generally to be somewhat larger than those of the previous day for the same number of cells joined up.

After this the photographic slides were again mounted in the place of the scale and the deflections registered, which on the sheets being measured gave results as follow :—

EXPERIMENT 6.

Positive.			
No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.
100	0·937	500	3·662
200	1·837	600	4·125
300	2·625	700	4·337
400	3·125	800	4·525

In the next experiment the deflections were measured for every twenty cells added on from 200 negative to 800 positive.

EXPERIMENT 7.

Positive.						Negative.	
No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.
0	0·000	320	2·475	600	3·925	0	0·000
40	0·525	340	2·600	620	4·000	20	0·100
80	0·650	360	2·750	640	4·075	40	0·275
100	(0·700)	380	2·875	660	4·125	60	0·500
120	0·900	400	3·000	680	4·175	80	0·725
140	1·075	420	3·075	700	4·225	100	0·950
160	1·250	440	3·175	720	4·275	120	1·175
180	1·425	460	3·300	740	4·325	140	1·425
200	1·600	480	3·400	760	4·350	160	1·675
220	1·775	500	3·525	780	4·375	180	1·925
240	1·950	520	3·625	800	4·400	200	2·175
260	2·100	540	3·700				
280	2·200	560	3·775				
300	2·350	580	3·850				

EXPERIMENT 8.

Positive.				Negative.	
No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.
100	1·058	500	3·942	100	1·108
200	1·943	600	4·358	200	2·323
300	2·686	700	4·625	300	3·663
400	3·488	800	4·810		

EXPERIMENT 9.

Positive.				Negative.	
No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.
100	0·976	600	4·097	100	1·149
200	1·843	700	4·359	200	2·429
300	2·591	800	4·561	300	3·853
400	3·203	900	4·686		
500	3·708				

By combining the results of all the above experiments, and taking the means for every hundred cells, we have the following table :

Positive.				Negative.	
No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.	No. of Cells.	Deflection in inches.
100	0·93	600	3·95	100	1·04
200	1·77	700	4·20	200	2·34
300	2·48	800	4·42	300	3·75
400	3·09	900	4·69		
500	3·57				

On laying down these values in a curve, making use only of those between the limits of — 200 and + 700, as the others are beyond the capability of correct registration by the electrograph, we find a regular smooth curve is produced (shown by the fig.), which being projected upon one of the ordinates, gives a scale by means of which the electrograms are now easily tabulated.

The value of the electromotive force of one De La Rue chloride of silver cell being 1·03 volt, as determined by Messrs. De La Rue and Müller (Proc. Roy. Soc., vol., xxvi. p. 324), the scale thus formed has been assumed to represent volts with sufficient accuracy for the required purpose.

My best thanks are due to Mr. Seaton and Mr. R. W. F. Harrison, for assistance rendered me in the prosecution of the experiments.

M. TROUVÉ'S TELEPHONE.*

I HAVE the honour to communicate to the Academy of Science the latest results of the researches I have made in relation to the telephone, by the application of multiple vibrating membranes, tending to reinforce the intensity of the transmitted currents.

In my communication of 10th December last, I announced that one could sensibly reinforce the intensity of the currents produced, and consequently the intensity of the sound itself; and to this end I adopted a polyhedral series of membranes vibrating in unison. The present is a new arrangement, which, taking advantage of the same principle, gives better results.

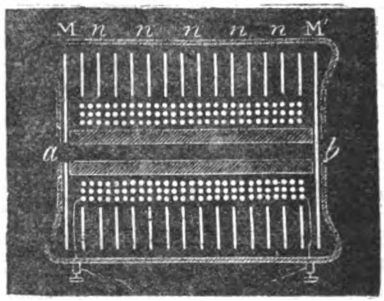
a b is a tubular magnet surrounded by a solenoid along its whole length. In front of one of its poles, *a*, is a circular membrane, M, similar to that of the ordinary telephone, but pierced at its centre by a hole, the diameter of which is equal to the external diameter of the tubular magnet. At the other pole *b*, is a similar membrane M′, not pierced.

The advantage of this combination will be easily understood: on speaking in front of that pole of the magnet before which is placed the perforated membrane M, the sonorous waves throw this into vibration and, continuing their path through the tube, cause the second membrane M′ to vibrate also. It follows that the magnet, being influenced simultaneously at both poles, sets up in the solenoid currents which are notably more intense than if it were influenced at only one pole and by only one membrane.

The receiver, similar to the transmitter just described, receives the corresponding currents; and these set the the two membranes into simultaneous vibration: the ear placed at *a* receives directly the sounds produced by the first membrane M, while those from the second reach it through the interior of the tube.

This novel disposition is most effective in comparing experimentally the results furnished by the single-membrane telephone (Bell's) with those furnished by the multiple-membrane telephone. In fact it is only necessary to listen alternately at the two faces of this telephone to observe at once a difference in the received sounds: those received at *a* appear sensibly double in intensity to those received at *b*.

The difference is still more striking if, while transmitting or receiving a sound of invariable intensity through the multiple-membrane telephone, the membrane M′ be occasionally stopped from vibrating. This determined, it is easy to see that one can augment the intensity of the currents and consequently of the sounds by intercalating between the two primary membranes a series of membranes, *n*, parallel and equidistant, surrounding the solenoid, and influencing it throughout its whole length.



The Academy will allow me at the same time to explain the principle of a new telephonic apparatus with which I have lately experimented, and which I propose to make the subject of a special note hereafter. It consists as follows :—

A vibratory metallic membrane forms one of the poles of a battery of high tension; the other pole is brought under the control of the plate by means of a micrometer screw, which allows the distance between the screw and plate to be varied, according to the tension of the battery, without their ever being in contact. This distance should never exceed that which the battery can spark across. Under these conditions the membrane, vibrating under the influence of sonorous waves, has the effect of constantly altering the distance between the poles, and so to vary incessantly the intensity of the current; consequently, the receiving apparatus experiences magnetic variations in proportion to the variations of the current, the result being that the receiving membrane is caused to vibrate synchronously.

The new telephonic apparatus is thus based upon the possibility of varying, within very wide limits, the resistance of the circuit external to a battery of high tension whose poles are not in actual contact. This resistance may be varied in its conditions by interposing a vapour or different media, such as air or gases more or less rarefied.—*La Nature.*

* Presented to the French Academy of Science.

AN IMPROVED TELEPHONE.

SOME important improvements upon Professor Bell's Telephone have recently been made and patented by Mr. E. Cox Walker, electrician (of the firm of Messrs. T. Cooke and Sons), of York. As is now pretty generally known, Professor Bell's telephone consists of a small bar magnet, around one end of which is wound a coil of fine silk covered copper wire, and a diaphragm of thin sheet iron or ferrotype.

Upon the diaphragm a mouth-piece is placed for the purpose of concentrating the voice of the speaker upon the centre of the diaphragm.

Connection being made by an ordinary telegraph wire, at the other end of which is another telephone, various articulate sounds can be conveyed to long distances.

Though almost any sound could be transmitted with wonderful distinctness, it was found both in practice and experiment that the utility of this novel instrument would be much enhanced if those sounds could be by any means intensified so as to relieve the auditor of undue attention, and avoid the necessity for the sender to speak with more than ordinary loudness. With this view experiments were made with enlarged diaphragms, but these, although giving more volume, causes a thickness and comparative indistinctness of the sound.

Theoretically, it might be supposed that if the transmitting power of the telephone could be doubled, and made to act in unison, that the intensity of the sound conveyed would be in the same ratio as the multiplication of the telephones, and in working out this idea Mr. Cox Walker has effected a valuable improvement. The improvement consists in doubling or quadrupling the diaphragm and its accessories, and dividing the mouth-piece so that to each 'diaphragm there is a corresponding sub-mouth-piece. Instead of using two or four single magnets, Mr. Walker adopts one or two magnets somewhat of a horse shoe shape, the coils being connected as for ordinary horse shoe electro-magnets, and the connections made with the transmitting wire in the ordinary way.

Taking the quadruplex mouth-piece as an example, it might be explained thus :—the ordinary single telephone mouth-piece is elongated, and instead of the orifice leading direct to the diaphragm it is divided into four smaller channels, each of which collects and directs the sound on to the diaphragms covering the magnets. Mr. Walker does not have a separate diaphragm for each pole or coil, but has so constructed the under side of the mouth-piece that it nips the diaphragms tightly across the middle and around the opening containing the coils, and virtually divides them.

We had the privilege a short time since of witnessing some experiments made with the improved telephones on Messrs. Cooke's premises in Coney-street, under the superintendence of Mr. Cox Walker. Conversations were carried on and songs were sung through both the single telephone of Professor Bell, and the duplex and quadruplex improved telephones of Mr. Walker. Comparisons could thus be made, and it was found that as nearly as could be calculated by the auditor the intensity of the sound transmitted through the duplex telephone was double of that transmitted through the single instrument, and the same proportionate increase was distinguishable in the quadruplex telephone. These results were obtained not only in the transmission of the human voice, but precisely the same effect was observable when the strains of a violin and a small musical box were sent through. The softest notes of the violin were heard with marvellous clearness, and the whole of the experiments were of the most satisfactory character.

Mr. Walker contemplates still further increasing the intensity of the sound by adding to the number of coils, diaphragms, and corresponding divisions in the mouth-piece, and he is hopeful that an octoplex telephone will give eight times the intensity of a single one. The improvements already effected will render the transmission, and especially the receipt of telephonic messages, a matter of much greater comfort and facility. Besides the mouth-pieces, Mr. Walker has patented improved ear-pieces, the advantage of which is that the ear-piece being tapered to a small point, the sound can be more easily concentrated on the tympanum of the ear, without at the same time occasioning any discomfort by the pressure of the instrument, in addition to which two ear-pieces can with facility be used at the same time.—*York Daily Herald.*

[The octoplex instrument has since been made, and the trials have resulted as anticipated. The instrument was exhibited at the Royal Society's soirée, on the 1st May, and at the Royal Institution, on the 3rd.]

THE NEW YORK FIRE ALARM TELEGRAPH BUREAU.

THE New York Fire Department is acknowledged to be the best, most efficient, and most complete of any in the world. That much of its efficiency is due to the use of the telegraph no one will question. Considerable changes and improvements have recently been made in the telegraph bureau, and several new instruments and apparatus added, so that to a visitor the place now presents an imposing appearance.

The operators' room is situated upon a raised platform in the front part of the building, and is enclosed by a cabinet of solid mahogany, carved in the most elaborate manner, the whole space occupied within the enclosure being twenty feet square. The lines from the various poles are brought through an iron frame work into the loft of the building, on which the lightning arresters are situated. From that point they are carried into the wood-work in such a manner as to be entirely hidden from view.

The switch board, which is of marbleised slate of the most beautiful design, is located on the southern side of the operating room. Here are also situated the galvanometers, which indicate at all times the condition of each wire and battery. From here the wires diverge toward the box circuits, being carried to the opposite side of the room, where the apparatus is placed on which the fire alarms are received.

By means of fire-stops all signals from the street boxes are transmitted to the company quarters direct, and without the loss of a second's time. The signals are received on the small gong in company quarters several seconds in advance of the signal on the large gong, on account of the size of the latter.

All the machinery used for sending and receiving alarms, signals, and messages is duplicated throughout, so that the failure of any piece of this great mechanism will not affect or delay the immediate reception or transmission of alarms. The

annunciator numbers after being dropped down from any cause are immediately restored to their places by electricity. The office is also provided with the most finished and improved apparatus for testing the wires, and calculating closely the location of any interruption or trouble which may exist on any of the circuits. There is also an instrument for testing automatically the alarm wires and making a register of such test once in every ten minutes, by means of a register provided for the purpose, and likewise showing the condition of these wires on a separate annunciator. There are sixty circuits, comprising forty-one box circuits, over which alarms are received; ten gong circuits, over which alarms are transmitted to the company quarters; and three dial circuits, and two tower circuits. An inspection of this beautiful piece of complicated and useful apparatus will well repay the visitor to the headquarters of the fire department.—*The Operator.*

POST OFFICE TELEGRAPHS.

The account of receipts and payments by the Postmaster-General in respect of the Post Office telegraphs for the financial year ending on March 31 has just been issued. It shows that the payments amounted to £257,743, of which sum the receipts fell short to the extent of £2,492. The capital account shows that out of a total authorised capital of £1,751,040, £1,610,005 has been expended. The Comptroller and Auditor-General, in his report, explains that the sum of £226,272 claimed credit for under the head of expenditure for telegraph undertakings includes certain amounts which have been excluded, as having been otherwise adjusted, and these sums being deducted, would leave the total expenditure for the year at £226,098, for which the Treasury authority has been furnished. The charge of £6,713 against the telegraph capital account is admitted, in pursuance of the recommendation of the Public Accounts Committee. During the year 18 of the officers of the late telegraph companies have commuted their pensions, and £18,413 has been paid to them. Appended to the Auditor-General's report is an abstract account prepared in his department showing the receipts on the telegraph capital account, from its commencement to the 31st March last, as having amounted to £9,609,741, and the payment to £9,612,079, leaving a deficit of £2,338. Out of the sum of £9,750,000, authorised under the Telegraph Acts of 1869, 1871, 1873, and 1876, expenditure to the amount of £9,612,079 has been allowed, leaving a balance of £137,921, to which must be added the sums received for the sale of premises, old fittings, and the steamer *Monarch*, £2,546, as shown in his previous reports, and the sum of £588 received from the Great Eastern and Cowes and Newport Railway Companies, and handed over, in pursuance of Treasury instructions, to the Paymaster-General, for the purpose of being placed to the credit of the telegraph capital account; making the total amount available for future expenditure £141,035.

Review.

Laying and Repairing of Electric Telegraph Cables. By Captain V. HOSKIÆR, Royal Danish Engineers. London: E. and F. N. Spon.

IT may not appear very creditable to the English telegraph cable engineering profession that the only work which has appeared bearing on the subject of cable laying and repairing, has been brought out by a foreigner, but the want of such a work cannot really be said to have been much felt. We think that there is more than one English telegraph engineer who would have brought out a book on the subject had there been any great need of such a production.

The little book before us, although bearing evident marks of being the work of a foreigner, is still a very creditable treatise, and contains much information. The author has had some considerable experience in cable laying and repairing, and is therefore very competent to write on the subject.

Almost every point to be considered in the laying of a cable is dealt with; the selection of a route, the proper steamers to carry the cable, the machinery employed on board, the proper way to coil the cables in the tanks, and the difficulties encountered in changing from one tank to another when paying out the cable, are well explained. Also the repairing of faulty cables is briefly but sufficiently considered; indeed, there is but very little of the superfluous matter which is usually considered so necessary in books dealing with technical work. Captain Hoskiær may be, perhaps, excused for introducing one or two sections dealing briefly with the mathematical theory of laying and picking up cables, as he is only following the usual practice in doing so, but the utter uselessness of such theoretical developments is perfectly well known to every practical cable engineer. As an exercise to the mind, the practice of mathematics is invaluable, and in a very large number of cases mathematical investigations are of great value to the practical engineer, and it is only those who are themselves ignorant of the subject, who say that mathematics are useless for any practical purposes, but still it is a pity that so much matter should be introduced into technical books, which would much better have a place in mathematical treatises.

Notes.

THE PARIS EXHIBITION—In the French Section of the Exhibition there is a very good display of telegraphic apparatus; but in the English, American, and other foreign sections there is very little apparatus to be seen. Messrs. Siemens, Bros., the British Telegraph Company, and the Telegraph Construction and Maintenance Company, exhibit a variety of the ordinary well-known telegraphic apparatus in use in England, Professor Bell exhibits his telephones, Mr. Jamieson his grapnel, and Mr. Sanderson some specimens of his lightning rods. Nothing is yet shown from America. In the French section the number of specimens of submarine cables shown is rather sur-

prising to English electricians, who are too apt to consider that nearly all the work of this kind is done in England. The principal exhibits are the Meyer multiplex apparatus, the Baudot apparatus, which is an application of the Meyer system of distributing the currents to the Hughes printer. There is a duplex Hughes also, which is employed in conjunction with Stearn's combination of resistance coils and condensers. There is a great variety of Morse instruments, French single needle instruments, and electric bells. The French Telegraph Administration exhibit specimen poles, construction tools, maps and models of the French lines, and the apparatus in use.

In the House of Commons on May 27th, in reply to Dr. Lyon Playfair, Sir H. Selwin-Ibbetson said that the report of the two officers (Messrs. Preece and Fischer), of the Postal Telegraph Service, who were sent to America last year to investigate and report upon the telegraph system of the United States, would not be printed or circulated, as it contained information of a confidential character, such being supplied by private telegraph companies in America with the understanding that it would not be made public.

The Amoy-Hongkong section of the Great Northern Company's Cables is under repair.

Mr. Frank L. Pope, the well-known American Telegraphist, has just arrived in England from the United States. We are much indebted to Mr. Pope for the admirable obituary notice of Professor Henry, the eminent American Electrician and Physicist, which appears in the present number of the Journal.

MR. EDISON finds that the hissing sounds are lost when spoken against the whole diaphragm of the phonograph. If the diaphragm be screened by another plate having a small hole with sharp serrated edges in it, they are, on the contrary, reinforced and recorded.

AN architectural photograph of a large building has been taken in Dundee by means of the light from a Gramme dynamo-electric machine of a power equal to 800 candles. The view was taken by fifteen minutes exposure in a crowded thoroughfare, during a drenching rain, and within an hour of midnight. The photograph could not have been taken so well by daylight, for the falling rain would have obscured it.

M. GRANFELD's new signalling instrument, which we heralded in our last number, is a multiplex Hughes instrument, called "Hughes' Perfector," and can be arranged to give as many as eight-fold messages. With 107 rotations of the chariot per minute, it gives an average of 30 telegrams for each keyboard per hour. Meyer's multiplex instrument, which receives four messages at once, gives a corresponding average of twenty-one telegrams per hour.

A statue of Jan Van Eyck, over twelve feet high, has been executed in bronze by electro-deposition, and set up at Brussels. The skin is about a quarter of an inch in thickness, and the likeness to the model is of course absolute.

THE system of "grading" salaries, which appears to be an official euphemism for salary reduction, recently introduced by the Western Union Telegraph Company, in order to curtail expenditure so as to pay a satisfactory dividend, is causing much dissatisfaction amongst American operators.—*The Operator.*

CAPE COLONY TIMBER FOR TELEGRAPH POLES.—*Knoppies dorn*, which is as hard when green as when dry, yields thick straight poles from thirty to fifty feet long. *Mapari*, and the scented wood *Tamboti*, are also good for poles. The white ants, so destructive of ordinary timber, do not molest these woods.

THE loyal subjects of Her Majesty at Esquimalt, British Columbia, had a bad scare the other day. The telegraphic cable between San Juan and the Lopez Islands broke—probably talked to death by the immense Russian names with which it had to wrestle during the past few months. The breakage occurred just at the time when war between England and Russia seemed imminent, and the news was left, like an interesting story, "to be continued." At this critical moment a Russian man-of-war put into Esquimalt for repairs. The valiant Britishers first thought they would open fire on the ship with their mountain howitzers. However, the Governor concluded it would be best to make assurance doubly sure, so he sent a boat over the Straits of Fuca to Port Townsend, the nearest point in the United States, to find out whether it was peace or war. It turned out to be the former, and so, that Russian war vessel still floats on the Pacific.—*The Operator.*

THE Eastern Telegraph Company announce that the Lisbon and Madeira cable has been repaired, and that direct communication is restored with South America.

THE Great Northern Company announce the establishment of a special courier service between Amoy and Foochow, a courier leaving each place for the other every day at 2 p.m., and occupying 45 hours in traversing the distance between them.

AT a conference of representatives of each of the Australian colonies held at Melbourne on the subject of telegraphic communication between England and Australia, it was agreed to accept the proposition of the Eastern Extension, Australasia, and China Telegraph Company to duplicate the cable between Singapore and Port Darwin, subject to the ratification of the Australasian Parliaments and the shareholders of the company.

DURING a recent telephone concert between Buffalo and New York, over a Western Union wire, the singers at Buffalo could be heard on a telephone in a private office in New York. An investigation showed that the private line, to which the telephone in the office was attached, approached at a certain place to the Western Union wire; but the distance between the wires could not be less than ten feet.

THE *Boston Medical and Surgical Journal* says that the utility of the telephone in the class demonstration of auscultative signs of disorder of the chest is being studied with good promise of success. Professor da Costa made a preliminary trial in March last, at the Pennsylvania hospital, of a Bell's telephone, constructed by Dr. W. B. Hopkins, a former resident. It was tested by cases of cardiac murmurs, and different varieties of respiration; and while the results obtained were not fully satisfactory, it was believed to be demonstrated that a slight modification in the construction of the instrument, enabling it to respond to more delicate impulses, would fit it for the purpose, and make it an almost indispensable adjunct to the clinical amphitheatre.

IN our last issue we stated that priority of invention of the phonograph had been claimed for an Italian. Our authority was mistaken. It should have been the speaking telephone.

WE understand that the firm of Messrs. Siemens and Halske, of Berlin, has received an order from the British Government to get ready as soon as possible 200 electric lighting apparatuses for the British fleet.

M. TOMMASI has described his new relay for submarine cable work to the French Academy. It consists of a powerful horse-shoe magnet with a very light magnetic system of two small parallel magnets between its poles. Each of the magnets is pivoted at its centre, and carries a little *taquet* intended to produce a jarring for the purpose of disengaging the contacts of the local circuit, and rendering the movements of the system more prompt. When no signals are received the moveable magnets are held in their zero position by a permanent magnet. The relay acts with reverse currents, and is arranged to operate Morse and Hughes instruments. It is so sensitive that it can be moved by the current from a cell composed of a copper wire and a zinc wire, dipping into a drop of acidulated water, passed through a plank of dry wood 20 centimetres long; that is to say, a resistance equivalent to several million kilometres of ordinary telegraph wire. Experiments with it at the Central Bureau of Telegraphs, Paris, over a line, 5,000 kilometres long, including 280 kilometres of subterranean wire, have shown that a single Daniell cell is sufficient to work the Morse with it. On the cable between Marseilles and Algiers, 500 miles long, 22 words a minute have been obtained by it from the Hughes instrument with the current from three or four Daniell cells; and by a particular arrangement, enabling the Hughes to act by reverse currents, 33 words per minute have been reached.

ON SOME PHENOMENA OF ELECTROLYSIS.—Amongst the well-known effects of passing a current of chemical electricity through a non-metallic conductor, are: (1). Electrolysis, whereby the electrolyte is divided into primary and secondary products, which, speaking generally, bear to one another and to the electrodes a relation homologous with that which the metals in the active cells bear to one another and to their liquids. (2.) There is a bodily carrying forward of the whole electrolyte in the direction of the current, and this is more marked according as the electrolyte is a worse conductor. (3). There is an action compounded of the above two. If sulphuric acid be electrolysed, the acidity is increased around the + electrode. If sulphate of copper be electrolysed between platinum poles, copper (as sulphate) travels to the — electrode, but not in sufficient quantity to replace that which is there deposited.—(Hittorf, Wiedemann.) Remembering the molecular indifference which crystalloids and colloids bear to one another, the question presented itself: Is there, in a mixture of the two kinds of matter, sufficient continuity and mobility amongst the crystalloid molecules to establish an electric chain? If there be so—molecular currents being wholly suppressed by the colloidal obstruction—a valuable means would be furnished for tracing the "wandering of the ions." Water was boiled with sufficient gelatine to form a stiff jelly. In this, while warm, a little sulphate of sodium was dissolved together with some litmus. To one portion a drop of dilute sulphuric acid was added, to another, a drop of ammonia. When the jellies had set in glass cells, pairs of sheet platinum electrodes nearly fitting the cells were thrust in, about two inches apart in both cases. Six pint platino-zinc battery cells were attached to each (in succession). Flattened bubbles of gas forced themselves up from both poles with a crackling noise. In a quarter of an hour, in the slightly reddened cell, both faces of the + electrode were clothed with a brighter and more transparent red envelope, but somewhat thicker towards the other electrode. The — electrode was coated with a transparent blue envelope. These two conditions spread, and met one another in about three-quarters of an hour, in a vertical plane between the two electrodes, somewhat less than twice as far from the — as far from the + electrode; the blue band being the widest. This plane was maintained for three hours after its establishment with the current in action, and kept the same for days after the current had been broken; although by automatic diffusion, the blueness and redness have spread backwards. A similar effect was produced in the blue jelly. The heat developed produced a slight fusion, which was confined to the — electrode.—PROF. GUTHRIE in the *Pop. Sc. Review*.

MR. T. A. EDISON has taken out a patent in the United States for a paper puncher, which will perforate a received message on a strip of paper, so that it may be automatically transmitted further on. The puncher is worked by a rotary electric-engine, and controlled by the armature of the receiving instrument.

WE learn from the *Journal of the Telegraph* that the "official gazette" of the U.S. Patent Office has been temporarily suspended, as also has the printing of specifications. This is due to the fact that the funds relegated to the Patent Office for publishing purposes by Congress have become exhausted, and a new allowance has not yet been granted.

MR. C. H. WILSON of America, has patented in that country a means of overcoming the troublesome mutual inductive action between two long parallel lines on which the duplex and quadruplex systems are at work. It consists in connecting up between the two artificial circuits of the duplex and quadruplex balances a series of condensers and rheostats, so as to neutralise the disturbance.

MR. M. H. ALBERGER, an American, claims to have discovered that a compound cable, formed of a copper conductor insulated with glass and sheathed in an iron tube, when heated red hot can be drawn out into wire like a bar of solid metal, the conductor remaining as perfectly insulated as before. The inventor proposes to use this cable for subterranean lines.

ELECTROLYTE DECOMPOSITION OF WATER.—Recent experiments of M. Bouvet, show that the amount of electricity required to decompose a given volume of water is the same at all pressures.

DISCHARGE IN VACCUO.—M. Warren de la Rue finds that vacua formed by the absorption of carbonic acid by potash, or of hydrogen by spongy palladium, are impassible by the current from as many as 11,000 chloride of silver cells. When the vacua are only partial, the discharge passes, and is so steady that all its striœ may be photographed.

WE have received an elaborately illustrated catalogue from the Scientific and General Novelty Company, Smithfield. It is replete with all the pranks of science and the tricks of parlour magic. In the electrical department our attention has been arrested by the phenomena which are styled the "Electric granules, or prismatic vital germs," for we thought we had at last discovered some clue to that mysterious but well-known scientific dogma, "Electricity is Life." We were disappointed, however, for a veil of secrecy enshrouds the matter. "This compound," says the learned author of the General Novelty Catalogue, "is entirely unknown in the scientific world, and its introduction has caused the most profound excitement; for the extraordinary changes it undergoes and the effects produced are positively unaccountable, and can only be ascribed to the existence of a *mysterious force* hitherto unknown."

THE phonograph may become useful in fixing, or at least perpetuating, the pronunciation of words. It was said by M. Paris, at a recent Conference of the Sorbonne, that if all the people alive who spoke French were suddenly exterminated, the survivors among other nations would be unable to exactly revive the present French pronunciation by the help of written records. With proper phonographic matrices such a catastrophe might be contemplated lightly by philologists and linguists. It may also happen that students in the future shall study the pronunciation of foreign languages by the help of a phonograph instead of a teacher. Properly prepared matrices in French, German, and American, giving all the characteristic nasals, gutturals, and twangs, being sold in the shops for a few shillings.

ELECTRIC STREET LAMP.—A trial was made on Monday night, May 6, of a street lamp for electric lighting, devised by Mr. Bore. The lamp is in rear a semi-hexagonal reflector, and the front is covered by a flattened convex opal glass, so that the intensely brilliant point of light emanating from the carbons is not visible, but instead a glowing white diffused light is very effectively radiated in all directions, giving a soft and very pleasant illumination of all objects in the roadway. In the electric light itself nothing new was attempted, the old Bunsen battery being the source and the Dubosq apparatus the manipulator of the points. Two of these lamps were kept in action for some hours, one at the Mansion House, the other at the Royal Exchange. With five such lamps placed in opposite directions, so as to obliterate the intensely dark shadows which the intensity of the electric light always produces when thrown on one side only of the place to be lit up the whole of the space between the Bank, the Exchange, and the Mansion House could be perfectly illuminated; and if the Siemens magneto-electric machines were employed the cost would be, we believe, considerably less than the present cost of the ineffective gas lights, which paled and grew dim before their two electric rivals. The effect produced by the opal glass is the very agreeable diffusion of light so pure in quality that colours in all shades can be nicely distinguished, whilst the lettering of omnibuses, newspaper and play bills can be read at many yards distance. For drivers of vehicles the effect of this diffusion of the electric light is everything that can be desired, and does not subject them to the serious inconveniences which they suffered from the glare of the naked electric lights hitherto presented to the public.

TELEGRAPH ROUTES BETWEEN ENGLAND AND INDIA.—At a recent meeting of the Society of Arts, Major Bateman Champain, R.E., read a paper, in which he traced the origin and progress of the leading schemes

propounded for securing rapid communication with our Indian Empire, and recounted the difficulties which had been experienced in carrying them into execution. Since the beginning of last year, the Eastern Company has been in possession of a complete doubled system of communication with the East, and the lines to India may be thus enumerated:—The Constantinople route to Fao, and single cables to Bushire; the distinct double line from London to Bushire, *viâ* Teheran; a gutta-percha cable from Bushire to Kurrachee; Hooper's cable from Bushire to Jask, and a double line from Jask to Kurrachee; a cable from Falmouth, *viâ* Gibralta and Malta, to Suez; land lines across France and Italy to Malta and Suez, and two cables from Suez to Bombay. Major Champain afterwards dealt at some length upon the question of telegraphic charges. A discussion followed, in which Sir James Anderson expressed the opinion that we had arrived at a period of our history when we must account with telegraphy. In the present case, although it might be hoped that war would not occur, yet if war were to occur, what would be the case if the lines were cut, and what would the nation do if war were to break out? This question should be discussed very carefully, and Government should devise a plan by which communication might be kept up with this country, and with other chief stations of the Empire. All our lines might be cut by an enterprising enemy, and the only way to secure neutrality of communication, was to establish so many lines by land and sea that the enemy would not think it worth while to cut any of them, because there would be so many, that communication could not be interrupted. So far as Europe was concerned, only about three despatch boats would be necessary to keep up the communication between the fleet and this country. Supposing war to break out, we should have a fleet at or about Besika Bay or the Dardanelles. Assuming that the lines in the Mediterranean were cut, a despatch boat could go—if we were friendly with Greece—to a near point on the coast of that country, and another might be despatched to Navarino, and thus, in a few hours, communication might be established with Italy. There might also be an establishment of communication by Malta or Gibraltar. If France were our friend, the communication by Tunis and the Algerian coast might be made available. If his suggestion as to cables were adopted, it would be of little use for the enemy to break the cables, as regards the Mediterranean. So far as Aden was concerned, after six weeks' notice, they might land the cable at various places, and it would only require two despatch boats to carry on the communication with Aden. Between Aden and Bombay we should have to make the best defence we could by vessels of war. Cables should be laid along the highways of commerce. Sir Frederick Goldsmid thought it desirable that a telegraphic line should be established which should stretch across to the head of the Persian Gulf without passing through Russian territory. Dr. Siemens thought that the communication between this country and India was pretty well established even in case of war. The telegraph might be regarded as neutral property by Russia, even if war were to break out. Mr. Hyde Clarke moved a vote of thanks to the lecturer for his valuable communication made to the society that evening. The Chairman, in seconding the motion, referred to the idea of Dr. Siemens that, in case of war with Russia, the telegraphic lines would be treated by that country under the rules of netruality; but he would observe that a short time since, such was the condition of the ordinary lines of communication, that recourse had to be had to Bombay for sending news to this country. Therefore, he thought our duty was to multiply lines of communication as far as possible, and a line of connection might be carried to such a point as Latakia.

IN an interesting communication to *Nature*, Mr. Robert Sabine states that the effect of surface tension produced by the action of light on crystalline selenium, are strikingly shown when the selenium forms one of the metals in a small voltaic cell. On constructing such a cell, by suspending a plate of selenium (annealed at 200° C.) from a platinum wire into a cell of water, in which a strip of platinum foil was likewise immersed, the selenium pole was found to be electro-positive to the platinum pole, the difference of potentials between them being about + 0·1 volts. On allowing light to fall on the selenium, it became at once electro-negative to the platinum, the difference of potentials being at first — 0·05 volts. This difference gradually lessened however, as the light was kept on until the selenium again became electro-positive to the platinum, and a constant condition was reached, at which the difference of potentials, though still positive in favour of the selenium, was less than when both metals were in the dark. Mr. Sabine found that the slightest shading of the light affected the electro-motive force of the couple, and he hopes to utilize the latter, by means of a mirror galvanometer and photographic paper, as a recorder of the intensity of daylight.

ELECTRIC RESISTANCE OF SELENIUM.—M. Frossmann, experimenting with bars of selenium, 2·5 centimetres long and two millimetres in diameter, enclosed in a brass tube, with an opening in its side to allow a beam of light to fall upon them, finds that the deflection on the galvanometer when the light impinges is proportional to the number of elements in the battery employed. Daylight produces the maximum effect, a spirit lamp flame producing but a small deflection. Of coloured lights, yellow gives the maximum and green the minimum deflection. The rays of a lamp transmitted by yellow and red glass give a more powerful effect than when allowed to fall direct upon the bars. Certain solutions, such as chloride of copper and indigo solutions, intercept the active rays completely; whilst others, such as chloride of chromium, and above all the solution of selenium in very opaque sulphate of carbon, give a greater effect than direct radiation.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

A Special General Meeting of this Society was held on Thursday the 23rd inst for the purpose of hearing a paper read by Mr. Preece, Vice-president, on the subject of Professor D. Hughes' investigations with the "Microphone." Dr. Siemens, F.R.S., President of the Society, occupied the Chair; and among the company we noticed the Duke of Argyll, the Earl of Stanhope, Lord Claud Hamilton, Lord Lindsay, Dr. Lyon Playfair, Professor A. Graham Bell, Sir William Thomson, &c., &c. A very large and evidently appreciative audience gave proof of the lively interest felt in the recent discoveries.

A microphone—we can scarcely say *the* microphone, as it may be so variously constructed—may be considered as a supplement to the telephone, its office being to take up and render audible, through the agency of the telephone, sounds which would otherwise be inaudible, or which would at least be so faintly audible as to be incapable of transmission by telephones alone. Its action depends on a now well known property of some substances, viz: that of varying their electrical resistance under varying physical conditions, such as stress, temperature, &c. The vast amount of interest awakened by the invention of the articulating telephone has caused experimenters in all parts of the civilized world to turn their attention to such phenomena, and there can be little doubt that many of them have obtained very similar results. Foremost among them, until now, was Mr. T. A. Edison of New York, who discovered that carbon varied its electrical resistance with variation of pressure, and who based his articulating telephone upon this principle. Now we have Professor Hughes to the fore, who shows us that not only carbon but several other substances possess this property, to a degree hitherto undreamt of, so much so that it is not necessary to apply the force through mechanical agency, as in the Edison telephone, the atmospheric medium itself being sufficient for the purpose. Thus, a wave of sound impinging upon the carbon or other substances, through which an electric current is flowing causes a variation of current strength; and if a telephone forms part of the circuit, this variation is audibly registered.

The apparatus required to exhibit the phenomenon may be of the simplest order; and much prominence, perhaps a little too much, was given by Mr. Preece to the primitiveness of the materials which it pleased Professor Hughes to employ. His battery consisted of three small tumblers, with a flat spiral of copper wire for the positive pole, and a strip of zinc for the negative pole, separated by wet clay. The telephone was of home make, and consisted of a bar magnet about 4 inches long, one half coil of an old electro-magnet, and a square piece of ferrotype iron, 3 inches square, clamped between two pieces of board, hollowed out at their centres. Match-boxes, halfpenny money-boxes, bits of card-board, and a liberal supply of sealing-wax made up the rest of the plant.

Starting with a clear preconceived idea of the probable results which might be looked for, Professor Hughes introduced into the experimental circuit a stretched wire, listening attentively with the telephone to detect any change that might occur when the wire was spoken to or set into tranverse vibrations by being plucked aside. Gradually, till the wire broke, the strain was varied, but no effect whatever was remarked except at the moment when the wire broke. The effect was but momentary, but invariably at the moment of breaking a peculiar "rush" or sound was heard. He then sought to imitate the condition of the wire at the moment of rupture by replacing the broken ends and pressing them together with a constant and varying force by the application of weights. It was found that, if the broken ends rested upon one another with a slight pressure of not more than one ounce to the square inch on the joints, sounds were distinctly reproduced, although the effects were very imperfect. He then gave up the wire, and cast about to find a substance or a combination of substances which, when influenced by sound waves, would transmit the sound to the telephone, and he found that, if he filled a small glass tube with a mixture of tin and zinc, known as "white bronze," plugged the ends with pieces of carbon, and connected the whole with a galvanometer in circuit, on slightly pressing the carbons, and thus compressing the metallic particles, he obtained a deflection in one direction, whilst on exerting a tensile strain on the glass, and thus slightly expanding the space occupied by the metallic particles, he obtained a deflection in the other direction. This seemed to show that the compression brought the metallic particles into closer and better contact, thus diminishing the resistance of the circuit, and *vice versa*.

Another form of transmitter tried by Professor Hughes he has himself described as follows:—"The tube transmitter consists of an exterior glass tube two inches long and one quarter of an inch in diameter. In it are four separate pieces of willow charcoal, each one a quarter of an inch long, and two terminals of the same material. The terminals are fastened in the tube and connected externally with the line, and internally with the four loose pieces. In this case A is made to press on B, C, D, E, and F, until the resistance offered to the electrical current is about one-third that of the line upon which it is to be employed. It may be attached to a resonant board by the ends A or F. If the result were simply due to vibrations, we should have A and B making greater contact at a different time from E and F, and consequent interference. If it were a simple shaking or moving of B, C, D, E, and F, it could produce no change, as, if B pressed more strongly on C, it would be lost on A, and also, if the tube were attached by the centre, we should have no effect; but, if, the effect be due to a swelling or enlargement of B, C, D, E, and F, it would make no difference where it is attached to the resonant-board, as is actually the case. Again, reduce the pressure of A upon B, &c., until they are not in contact, and no trace of current can be perceived by shaking the tube. The instant the sonorous vibrations pass in the tube there is electric contact to a remarkable degree, which could only have taken place by the molecules enlarging their sphere under the influence of the sonorous vibrations."

Other and simpler combinations were next tried, with surprising results. A heap of clean small shot; two French nails laid parallel to each other, and a third lying across or laid between them; a pile of nails stacked timber-fashion; all these and many others were found to form excellent transmitters.

Pre-eminent, however, among sensitive transmitters stands carbon in its various commercial forms: gas-carbon, willow carbon, such as is used by artists, ordinary charcoal, &c. To get the most sensitive condition, the carbon is "metallized" by being heated while hot and plunged under mercury. By this means the pores, in consequence of the partial vacuum produced by the cooling, become filled with mercury in a state of very fine division, and the highly resisting carbon is thereby rendered a good conductor. It may also be metallized with iron.

A small bar or cylinder of this metallized carbon is

pivoted on a pin, being nicely balanced, so that one end just slightly preponderates and rests upon another piece of the same material. Or a spindle-shaped piece (like the schoolboys' "cat"), may be lightly jammed between two cheeks of the same material, or may rest in small cavities hollowed out of these cheeks. The whole is mounted on a piece of thin board or on a sounding-box, and wires are attached for conveying the battery current. The slightest noise made on or near this box is attended by a distinct sound in the telephone, even the dropping of a piece of tissue paper on to the box being sufficient.

A number of interesting experiments were shown by Mr. Preece, to illustrate the marvellous powers of these simple instruments. Breathing, whistling, singing and talking carried on near a microphone in an adjoining room, were reproduced in the theatre, as were also the ticking of a watch, a small clock, and a metronome. By means of a large tin trumpet, fitted by Mr. Preece to a box telephone, these sounds were rendered audible to the whole audience. Captive flys in cardboard prisons were also made to announce through hand-telephones their peregrinations in search of a means of escape.

A short discussion followed Mr. Preece's address, and was joined in by Professor Hughes, Professor Bell, Mr. L. Clark, and Mr. Willoughby Smith. The latter held that the action of the microphone was simply a case of "false contact," or very sensitive make-and-break arrangement. In evidence of this, Mr. Smith adduced an experiment of his own in which a delicate spring, weighted at the end, had been so finely adjusted that the faintest sound in its neighbourhood was sufficient to cause it to make contact with a metal stop. The noise produced in the telephone then only depended on the battery power employed. On the other hand, Professors Bell and Hughes thought the variations of current strength were due to the varying pressure bringing more or fewer points of surface into contact, and so altering the electrical resistance.

The Duke of Argyll and Dr. Lyon Playfair humorously appealed to Professor Hughes to provide an antidote to his own invention, and so foil the attempts of the eavesdropper.

A very hearty vote of thanks was accorded to Professor Hughes for his discoveries, and to Mr. Preece for his able discourse, delivered in his best style; and the meeting was then adjourned to Nov. 13th.

PHYSICAL SOCIETY.—MAY 11th, 1878.

Prof. W. G. ADAMS, President, in the Chair.

THE following candidate was elected a Member of the Society:—Rev. P. Magnus, B.A., B.Sc.

Mr. J. NORMAN LOCKYER, F.R.S., read a paper on "Some Recent Researches in Solar Chemistry," a report of which is deferred until next week.

Sir WILLIAM THOMSON, L.L.D., F.R.S., described and exhibited the apparatus he has employed in recent researches on the influence of stress on magnetisation, a detailed account of which he has just submitted to the Royal Society; he also, in part, described them at the Royal Institution on the 10th inst., but attention was not then directed to the experimental details now brought before the Society.

The rod or wire under examination was surrounded by two coaxial wire helices, the outer of which was connected with the battery, and the inner with a ballistic galvanometer; that is, one that acts with regard to electric impulses just as Robins's ballistic pendulum.

It was some years ago discovered by Villari that a longitudinal pull augments the temporary induced magnetism of soft iron bars, or wires, when the magnetising force is less than a certain critical value, and diminishes it when the magnetising force exceeds that value; in either case the residual magnetism is augmented when the force is applied, and diminished when it is removed.

Sir W. Thompson has found the critical value for soft iron to be about 24 times the vertical component of the earth's magnetic force, or 10 C.G.S. units. In the case of some bars of nickel and cobalt, specially prepared for him by Mr. Wharton, of Philadelphia, he finds opposite effects. With the amount of magnetising force used, the effect of pull was to diminish magnetisation, but the amount of this effect was less with the highest magnetising forces than with a certain degree of magnetising force which was found to make it a maximum with probably or possibly a critical value. But this value had not been reached by the magnetising force hitherto applied.

The next branch of the inquiry had reference to transverse stress, obtained by water pressure within a gun-barrel, and it was ascertained to have an opposite effect to that found by Villari, in the case of longitudinal pull; the critical point in soft iron for transverse pull, is at about 25 C.G.S. units. Sir W. Thomson has been examining the effect of torsion on a wire that is at the same time exposed to longitudinal pull, confining himself in his first set of experiments to magnetisation, under the sole influence of the vertical component of terrestrial magnetism. His results showed, with every amount of longitudinal pull, a diminution of magnetisation produced by torsion in either direction, thus extending a conclusion arrived at by Matteucci, Wertheim, and Wiedemann, regarding the effect of torsion unaccompanied by longitudinal stress. But it now appears that this effect of torsion is very remarkably diminished by a large pulling force nearly reaching the limits of elasticity.

In conclusion, Sir W. Thomson called attention to a very different and extremely interesting effect of torsion, discovered by Wiedemann—the development of longitudinal magnetisation in an iron wire by twisting it while a current of electricity is flowing along it. This effect, he pointed out, is just what would result from the œolotropic susceptibility for magnetisation due to the œolotropic stress produced in the outer portion of the wire by the torsion, supposing the tangential magnetising force to be less than a certain critical value, intermediate between the Villari critical value and the more than twofold greater critical value which Sir William Thomson has found for transverse magnetising force. But he pointed out that another cause was also positively or negatively efficient in contributing to Wiedemann's result. This cause is the difference of electric conductivity in different directions, which may be inferred from Sir W. Thomson's early experiments, and from Mr. Tomlinson's recent confirmations and extensions of the conclusions to which he was led regarding the effect of stress on the electric conductivity of metals.

It is much to be desired that Mr. Tomlinson should continue his experiments; but in the meantime it seems probable that the electric conductivity in the outer parts of an iron wire twisted within its limits of torsional elasticity is maximum and minimum in the two spirals at 45° to its length; being minimum in that one of them which is of the same name as the twist, that is, the one in the direction of the maximum extension of the substance; and the conductivity is a maximum in the other 45° spiral, which is the direction of maximum contraction of the substance.

The effect of this œolotropic conductivity, if it exists, must be to cause the electric currents to flow in spirals

of opposite spirality to that of the twist, and to produce a corresponding amount of longitudinal magnetisation. The effect of this is to develope, at the end by which the current enters, a true South Pole when the twist is right-handed, and a true North Pole when left-handed, which is opposite to Wiedemann's result. And if the tangential magnetising force exceeds the critical value, the effect of the œolotropic magnetic susceptibility also is opposite to Wiedemann's result.

This is a subject of great interest, and requires further investigation.

AT the meeting on MAY 25th, 1878, Prof. W. G. ADAMS, President, in the Chair, the following candidates were elected members of the Society:—W. Kieser, T. McEniry, W. R. Philips, and G. M. Whipple.

Mr. D. J. BLAIKLEY read a paper on "Brass Wind Instruments as Resonators," describing an attempt he has made to carry into some detail certain acoustical investigations of the late Sir C. Wheatstone, who proved experimentally that a complete cone gave resonance to the same notes as an open cylindrical tube of equal length. A method by which the positions of the nodal points in a cone and in a bugle had been fixed was shown, and attention was drawn to the fact that the position of the centre of magnitude of any closed conical tube was at the same distance from the open end as the centre of magnitude of a closed cylindrical tube of the same pitch. It was then shown that a complete cone cannot be used by the lips as a wind instrument; that conic frustra cannot give resonance to the same series of notes as complete cones, and that therefore the conical form must be modified; and, as this modification of form makes the position of a node for every note required more or less coincide with that of the lips, so will the instrument be more or less perfectly in tune. As the number of quarter-wave lengths in a cone or wind instrument is not directly proportional to the vibrational number of the note, as it is in free space or in an open tube, so the velocity of the wave of a given note is not exactly the same as that of another note of different pitch. Experiments were shown to illustrate the effect of varieties of form in producing different qualities of tone, and evidence was given of the existence of very high harmonic or partial tones in the low notes of wind instruments. In the trombone the ninth partial tone (three octaves and a tone above its prime) was thus proved to be sounding, and partial tones up to the sixteenth have been heard. In conclusion, a summary was given of the partial tones sounding in the tones of different instruments, and attention was drawn to the chief differences in form which influence quality of tone.

SIR W. THOMSON pointed out the connection between the range of a musical instrument and the phenomena observed in a trumpet-shaped bay between high and low water; and he considered that an investigation of the overtones due to the cavity of the mouth would well repay research in explaining the influence its shape has on the vowel sounds.

LORD RAYLEIGH observed that in a conical musical instrument the correction to be made on account of the cone not being perfect to the apex is equal to six-tenths of the radius of the open end, and he pointed out that with a bell-mouthed instrument much of the sound is diffused as spherical waves.

Dr. GUTHRIE placed on the table a communication on salt solutions and attached water, and on the separation of water from crystalline solids in currents of dry air, in continuation of his researches which have already been published. The results could not be usefully abstracted, but as an instance of the important results obtained, it may be mentioned that Dr. Guthrie finds that when dry air is passed over chloride of barium at a temperature just above 25° C., the β molecule of water is given off, and that the α molecule of water is only separated at a temperature just above 60° C. In studying the effect of media other than water in the solution of salts, he finds, for instance, that two solutions of cobalt of equal strength differ greatly as to colour if they are formed with water and glycerine. He has also traced the influence of a colloid in modifying the crystalline form of salts; for instance, sulphate of copper crystallizes from gelatine in the globular form, retaining only the $3\frac{1}{2}$ molecules of water. He also showed the effect of a steam jet in boring through a block, mainly with a view of obtaining suggestions as to the use of such a method in the commercial preparation of ice.

Mr. RUTHERFORD then showed a photograph of the solar spectrum from the line E to H, taken by means of a grating. By means of a heliostat he concentrated the rays of a lens within a collimator, which, in relation to the observing telescope, was of considerable length, in order to admit as much light as possible, and the grating was moveable. The enlargement was effected by inserting a lens near the focal point of the observing telescope, and he used a sensitive collodion, which gave the greatest sharpness of definition about the line G.

Sir W. THOMSON hoped that Mr. Rutherford would measure the wave lengths of dull radiant heat, as such rays are not absorbed by speculum metal, and we have as yet no idea of the lower limit of the waves of heat.

Sir W. THOMSON, in continuation of the communication made to the Society at its last meeting, described the effect of torsion on the electric conductivity of a tube of brass. He showed that the effects of pull and thrust were different, and that, in the case of a tube, as in the case of a plate, there is a diminution in conductivity in the direction of pull; in the case of the tube, however, the components of the forces result in a sort of eschelon arrangement as regards conductivity. The experimental part of the work was conducted by fixing the tube to a collar of brass, which was attached to a stand, the tube being arranged in a horizontal position. A magnetometer bearing a mirror could be placed inside the tube, and the changes in its conductivity, produced by torsion, were rendered evident by a reflected beam of light. The effects were also investigated by placing a core of soft iron in the tube, a balanced magnetometer being arranged outside the tube, near one end of the soft iron. Any changes in the conductivity of the tube, induced by torsion, were rendered evident by the changes in the amount of magnetism induced in the soft iron, as indicated by the magnetometer.

THE INSTITUTION OF CIVIL ENGINEERS.

AT the meeting on Tuesday, the 30th of April, Mr BATEMAN, President, in the Chair, the Papers read were descriptive of three bridges on the Punjab Northern State Railway, viz.: "The Ravi Bridge," by Mr. R. T. Mallet, M. Inst. C.E.; "The Alexandra Bridge, over the Chenab," by Mr. H. Lambert; and "The Jhelum Bridge," by Mr. F. M. Avern, M. Inst. C.E.

The bridge over the Ravi at Lahore consisted of thirty-three spans of 90 feet in the clear, and $97\frac{1}{2}$ feet from centre to centre of the piers. The piers were of brickwork, each founded on three brick cylinders, sunk 70 feet below the lowest water-level. Eight vertical tie-bars were built into the brickwork. The girders were of the parallel flange type. The lattice-bars formed two series of triangles, inclined at 45°. The super-

structure was designed to carry a footpath on the lower flange, and an asphalte cart roadway, flush with the railway, on the top. The cross girders carrying the railway were suspended in stirrups from the upper flange. The bricks for the foundation cylinders were of three special forms. The excavation of the cylinders was effected principally by Bull's dredgers; Fouracres' "spider" also proved efficient for the purpose. The floating of the girders for the spans over the main channel of the river was accomplished by four native barges, on which timber staging was erected.

The Alexandra Bridge was 9,300 feet long and 100 feet deep. The first brick was laid on the 1st of November, 1871. The first train crossed the bridge on the 23rd of December, 1875; and it was opened on the 27th January, 1876. Various works were undertaken to improve the site of the bridge. The first was to close the Wuzerabad navigable channel by an embankment $\frac{3}{4}$ mile long. A second embankment extended from the southern abutment of the bridge to the Pulkoo Nullah, to prevent the water of the river pouring into the Wuzerabad channel during floods. A third work deflected the stream at right angles to the general alignment of the railway in a direct line through the bridge. A fourth main work, being a star-shaped spur of trees and stones, was to prevent the river cutting behind the abutments in the event of disaster to the up-stream works. Several subsidiary works were executed of rough tree-spurs to catch floating sand, and to assist in turning the stream towards the centre of the river. The Chenab was crossed by Warren girders, these being sixty-four spans, 142 feet from centre to centre. The bridge over the Pulkoo back channel consisted of nine spans $43\frac{1}{2}$ feet from centre to centre, with piers of single well cylinders sunk into the clay substratum underlying the river bed. The girders were of plate iron, carrying the rails on the top.

The Jhelum Bridge was situated on the line of the Grand Trunk Road, the river being about 5,000 feet wide. The length of the bridge was 4,875 feet between the abutments, with training works on the left bank. There were 50 spans of 90 feet each, giving 49 piers and 2 abutments.

At the meeting on Tuesday, the 7th of May, Mr. BATEMAN, President, in the Chair, the Paper read was on "The Construction of Steam Boilers adapted for Very High Pressures," by Mr. Jas. Fortescue Flannery.

By an extension of the heating surface in relation to the grate surface, so that the temperature of the escaping gases might be reduced to a minimum, the evaporative economy of all boilers might be made nearly the same, but a boiler having favourable disposition of the surfaces would more readily be adapted to such reduction of the temperature of the escaping gases, and the maximum efficiency could accordingly be obtained in such a boiler with the least extension of the heating surface, and therefore with the least size and weight. On this ground alone it was believed that important economy might be obtained by the use of the water-tubes

Another important advantage incidental to the water-tube or sectional boiler, if well designed, was its facility for expansion and contraction under varying temperatures without undue strain upon the joints.

In connection with the question of weight, which had such an important bearing upon the policy of fitting tubulous boilers for marine purposes, there were one or two points demanding consideration. When comparing the total weight of machinery of different types, it was only fair to include the weight of coal necessary for a given number of days' consumption in each case, and, regarded in this light, the tubulous boiler by reason of its greater economy would have some advantage.

A point of importance was the free access to all parts of the boiler for the purpose of cleaning. From the nature of the case the tubulous boiler was difficult to arrange in this respect, and some examples, after working well for a time, had failed from the large deposit of scale for which no ready means of removal were provided.

At the meeting on Tuesday, the 21st of May, Mr. W. H. BARLOW, F.R.S., Vice-President, in the Chair, the Paper read was on "The Design generally of Iron Bridges of very large Spans for Railway Traffic," by Mr. T. C. Clarke, M. Inst. C.E. of Philadelphia.

The longest railway girder yet constructed, at Cincinnati, with a clear span of 515 feet, was that over the Ohio; the next longest, the Kuilenburg Bridge, in Holland, being 492 feet. The arches of the Saint Louis Bridge were also 515 feet span. Almost all American bridges of spans exceeding 100 feet were pin-connected, instead of being united by riveting.

The Ohio Bridge consisted entirely of rolled iron, pin-connected. The girders were quadrangular, each $51\frac{1}{2}$ ft. deep, the panels being $25\frac{3}{4}$ ft. long, and the girders 20 ft. apart from centre to centre. The weight of iron in the span of 515 ft. was 1,176 tons. With a total load of 431 tons, the centre deflection of the east truss was 2 [illegible] inches, with a permanent set of $\frac{1}{16}$ inch, that of the west truss being 2 inches, with no permanent set.

The Kentucky River Bridge had shore spans hinged at points 75 feet from the piers, with a centre girder 525 feet long, supported by piers 375 feet apart.

In conclusion, the author stated that the workmanship of long-span bridges in the United States was generally first-class; and that the price of American bridge work had fallen year by year, from £40 6s. per ton in 1870 to £20 16s. per ton in 1877.

On Tuesday, the 28th of May, the discussion on Mr. T. C. Clarke's Paper on "The Design of Iron Railway Bridges of very large Spans," was continued throughout the evening.

The President's conversazione, for gentlemen only, will take place in the India Museum, South Kensington, on Monday, the 3rd of June, being the fiftieth anniversary of the granting of the Royal Charter of Incorporation.

THE METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this society was held on the 17th inst., at the Institution of Civil Engineers, M. C. Greaves, F.G.S., President, in the chair.

The following papers were read:—"On the Daily Inequality of the Barometer," by W. W. Rundell, F.M.S. "Meteorology of Mozufferpore, Tirhout, for the year 1877," by C. N. Pearson, F.M.S. "Note on the great Rainfall of April 10th-11th, as recorded at the Royal Observatory, Greenwich," by William Ellis, F.R.A.S. "Observations of Sea Temperature at Slight Depths," by Captain W. F. Caborne, F.M.S.

The meeting was then adjourned till Wednesday, the 19th of June.

General Science Columns.

CONTINUOUS BRAKES.

THE importance of introducing continuous brakes on railway trains was first prominently brought forward in this country by a select committee of the House of Commons, which was appointed in April 1870, "to enquire into the law, and the administration of the law, of compensation for accidents, as applied to railway companies, and also to enquire whether any and what precautions ought to be adopted by railway

companies with a view to prevent accidents." Upon the second head of the reference appointing it, this committee made no proposals, though it recommended to the careful consideration of railway boards the evidence it had received in favour of the block and interlocking systems, and of continuous brakes. The report of this committee, however, led to the passing of The Regulation of Railways Act, 1871, under which large provisions were made for the inspection of railways by the officers of The Board of Trade, and for the investigation by them of accidents in serious cases, the companies being bound to make a report of all such casualities. In June 1874, a Royal Commission was appointed "to enquire into the causes of accidents on railways, and into the possibility of removing any such causes by further legislation." The report by this Commission was not made until February 1877. In it are contained many important statements of fact and suggestions connected with the importance of continuous brakes on railways, with a view to the avoidance of accidents and insuring the safety of passengers by railways. The subject of this report has already been dealt with by the scientific press, and, therefore, only a passing reference to its recommendations seems to be here necessary, in order that the whole question of continuous brakes may be fairly and comprehensively placed before the readers of this *Journal*.

The Commissioners in their report referring to brake-power on trains, observe that it is one of the most important subjects connected with railway management, the inefficiency of which has been the most fruitful cause of accidents in a long list of railway disasters. This subject had been investigated by the Committee of 1850, and it would be impossible to express a stronger opinion on the subject than was given by that and by other committees, which subsequently investigated the causes of accidents; but the recommendations of those committees were not attended to by the companies. The enquiries made by the commission proved that not only was there generally an insufficiency of controlling power in trains, but also that the distance within which a train running at high speed could be stopped by the brake-power ordinarily in use, was not ascertained with any approach to accuracy. They, therefore, applied to the railway companies to institute a definite series of experiments, to test the amount of control given by the brake-power ordinarily applied to their trains, and the effect of various systems of improved or continuous brakes. Several of the leading companies willingly responded to these suggestions, and the experiments were carried out with great care and at considerable cost on a selected position of the Midland Railway, near Newark, under the supervision of Mr. Edward Woods, M.I.C.E., and Colonel Inglis, R.E., assisted by a detachment of Royal Engineers, under Lieutenants Scott and Sankey. From these experiments it appears that the amount of hand brake-power usually supplied with the trains of the respective companies, failed to bring up the London and North Western train within 2,374 feet, that of the Caledonian Company within 3,190 feet, that of the Midland within 3,250 feet, that of the Great Northern within 3,576 feet, and that of the Brighton within 3,690 feet; the speed of the trains varying from 45·5 to 48·5 miles per hour. These trains were in the most complete order, and the guards and drivers had notice of the exact spot at which the signal to stop would be given. A large addition must, therefore, be made to these distances in practice, and, the Commisioners remarked, unless much greater control is obtained over trains by additional brake-power, it is clear that to ensure safety, the distant signals must be, for a level line, carried back to the distance of a mile; but, they added, it is evident that there are ample means of controlling trains within much less distance by some of the various systems already in use; and they expressed a decided opinion that no train could be considered properly equipped which was not furnished with sufficient brake-power to bring it, at the highest speed at which it would be running upon any gradients within its journey, to an absolute stop within 500 yards, and they recommended that this should be made obligatory by statute, and that sufficient powers should be conferred on the Board of Trade to enforce compliance with it. They also attached great importance to the necessity that a large proportion of the brake-power should be under the control of the engine-driver, who is generally the first to become aware of apprehended danger. No matter how small the interval of time required for the driver to attract the attention of the guard, it may be of vital moment in the case of a train travelling even at the moderate speed of 30 miles an hour, as every second which elapses brings it 44 feet nearer to the point of danger. Colonel Hutchinson, giving evidence on the subject in 1874, stated that he found that out of 85 cases which he investigated in the preceding year, 35 cases would either have been mitigated or prevented by continuous brakes in the hands of the drivers, and Captain Tyler attributed the greatest railway accident which ever took place in this country—that at Shipton, in 1874—in which 34 passengers were killed, and 65 passengers and four servants of the company were injured, in a great measure to the want of brake power, "If the train," he stated in his report, "had been fitted with continuous brakes throughout its whole length, there was no reason why it should not have been brought to rest without any casualty." The want of sufficient brake-power is certainly assigned as the principal cause of railway accidents, and it may be said that few cases occur in which the results would not have been at least modified by efficient continuous brakes. In a Parliamentary paper quite recently issued, reports on several accidents are given in which this would have been the case. Thus, in the collision on the 17th November last, on the Great Eastern Railway, between Loughton Junction and Chobham Farm

Junction, Colonel Yolland states, "It would probably not have occurred if the 7.50 p.m. up Loughton passenger train had been fitted with continuous brakes throughout its whole length, under the control of the driver, instead of their being only on one-third of its length." Again, regarding a collision on the Lancashire and Yorkshire Railway, between a passenger train and a goods train, on the 13th November, at Ratcliffe Bridge Station, General Hutchinson remarks, "It is probable that had the driver of the passenger train had control of the whole of the break power with which it was supplied, he might have stopped in time to have avoided the collision." In this case the engine and tender were fitted with a vacuum brake; the train consisted of seven vehicles, of which the five last were coupled together with Fay's patent continuous breaks. Another case was an accident on the London and North Western Railway, which occurred on the 15th August last, between the Moor and Warrington stations, which also might have been avoided had there been sufficient brake-power on the train. It was fitted with Clarke and Webb's continuous brakes, but the driver of the train, though aware about 1,500 yards from the spot where there was danger ahead, failed to stop in time, and ran at a speed of four or five miles an hour into a gap of 30 yards caused by the absence of three lengths of rails which had been removed, and had not been replaced in time. Another accident occurred on the same line of railway on the 3rd October, at Eccles Junction, when a train, from Liverpool to Manchester, came into collision with an engine and van. The train was only partly fitted with Clarke and Webb's brake, and the driver was enabled to apply it to only two out of the seven vehicles composing the train; and General Hutchinson observes that "had he been able to apply brakes to the whole, or even to the five coaches, the speed would have been so much more reduced as to have most likely given the engine and van time to have crossed to the branch before the fast train reached the 'crossing.'" And he adds, "Again, therefore, I think the public safety will not have been sufficiently provided for until these fast trains are supplied with far more ample brake-power than the one in question." On several other occasions, also the defective character of the Clarke and Webb brake has been commented on by the Board of Trade; and, in a letter to the London and North Western Railway Company, of the 15th January last, the attention of the directors is again drawn to "the necessity of adopting a proper and efficient brake" on their railway.

The foregoing are a few cases only out of those that have recently occurred in which accidents might have been mitigated, or altogether prevented, by the use of efficient continuous brakes. The experiments undertaken at Newark, at the instigation of the Royal Commission most clearly demonstrated the value of continuous brakes. The Board of Trade accordingly took up the question, and in a letter to the Railway Companies' Association it was suggested that a committee might, with great advantage, be appointed to consider the question of brake-power. "The general adoption of the most efficient form of brake-power, it was remarked, is "obviously important, both in the interests of the companies themselves, and in that of the travelling public," and it was declared that the time had come for decisive and harmonious action. In reply it was stated that the principal railway companies were, and had been for some time past, engaged in testing, in daily practice, one or other of the most suitable forms of continuous brakes, and that such brakes were already largely applied to express and other trains on some of the principal through lines of the country, and were in actual and serviceable use daily. In addition to this direct and practical trial, it was also stated that companies representing 12,000 miles of railway, or four-fifths of the whole passenger mileage, were testing, in the common interest, and with the object of elucidating the action of continuous brakes under all conditions, one or more of the following brakes:—

Clarke and Webb,
Westinghouse,
Smith's Vacuum,
Barker's Hydraulic,
Newall and Faiz,
Steel and McInnes,
Saunders,
Heberlein.

The ascertained efficiency of each of these brakes will be examined in a future article, but before doing so, it may be desirable to conclude the present general account with a brief consideration of the requirements that should be demanded of a really efficient continuous brake. The Board of Trade have forcibly impressed upon the railway companies how important it is that they should agree upon the adoption of one uniform system of brake power, for it is obvious that in the interchange of rolling stock, including ordinary carriages, saloon and family carriages, horse-boxes, carriage and fish trucks, and other vehicles forming part of passenger trains, between one line and another, if the brake fittings are not similar, the efficiency of the brakes must be proportionately impaired, and that this must be especially the case where the lines of two or more companies are continuous. The requirements which, in the opinion of the Board of Trade, are essential to a good continuous brake, are as follows:—

1. The brakes to be efficient in stopping trains, instantaneous in their action, and capable of being applied without difficulty by engine-drivers or guards.

2. In case of accident to be instantaneously self-acting.

3. The brakes to be put on and taken off (with facility) on the engines and every vehicle of a train.

4. The brakes to be regularly used in daily working.

5. The materials employed to be of a durable character, so as to be easily maintained and kept in order.

THE CHANNEL TUNNEL.

Explorations of the sea bed in the line of the proposed Channel Tunnel, were made by French engineers in 1875 and 1876, with the view of obtaining further indications as to the nature and condition of the geological strata through which the proposed tunnel would pass. Their reports published last year describe in full detail the results at which they have arrived; and Mr. W. Topley, F.G.S., has summarised and commented on these results in a report presented this year to the Channel Tunnel Company. He is of opinion that the geographical map made by the French engineers may be accepted as correct, considering the very great care taken in compiling it; and though the outcrops of the various chalk beds may be doubtful in some places, that of the Gault, which is much the most important, is probably accurate. From the section of the strata under the straits, inferred from the results of the explorations, it appears that the line of the tunnel, as laid down by Sir J. Hawkshaw and Mr. Brunlees, would lie almost entirely in the lower chalk, and that it would only traverse for a distance of one or two miles, the lower part of the upper chalk, which could not be avoided without giving a curve to the tunnel. At that depth the upper chalk is probably little inferior in compactness to the lower chalk, and the line proposed appears to be the best that could be adopted. The researches show that it is highly improbable that any great fault exists across the line proposed for the tunnel; and the only fault discovered runs parallel to the line of the tunnel, and being five miles distant, could not possibly affect it. These results are very satisfactory, and show that there is every probability that the channel tunnel could be executed without any unusual difficulties. Chalk is a good material for tunnelling in, and as 200 feet of solid chalk would be interposed between the tunnel and the bed of the sea, the infiltration would be insignificant. The finance question remains as the chief impediment to the execution of this bold project, and in the existing depressed state of trade, and owing to the unwillingness of the two railway companies which share the continental traffic, to contribute to the undertaking, it is doubtful whether funds will for the present be forthcoming for carrying out this enterprise. The cost of the trial heading from shore to shore, for removing all doubt as to the existence of a fault, is reckoned at £2,000,000; and the cost of the subsequent enlargement of the heading, and the connecting of the railways on each side of the channel is estimated at £6,000,000, making a total of £8,000,000. It is remarkable that during the last few years the French have shown much more activity than ourselves in promoting the scheme; and it is probable, judging from the energy of the French displayed in the execution of the Suez Canal, that if our positions had been reversed, and that a tunnel was the only means by which the French could obtain direct railway communication with the continent, the scheme would, ere this, have been undertaken in earnest.

FORESTS AND FAMINES.

The duties of an engineer, in overcoming the forces of nature in order to alter the conditions of the earth's surface the better to adapt it for the requirements of man, which are ever increasing with the increase of population, are continually developing and extending, and the highest scientific attainments are necessary, at the present day, when few branches of science exist that may not demand his attention. In the present article we desire to point out how, particularly in eastern climates, a knowledge of meteorology is necessary in order to aid in the protection of human life in those parts where famines are of periodic occurrence. A history of the past famines of India seems to demonstrate that these afflictions are of periodical occurrence, the most severe visitations having occurred, during the past 100 years, in cycles of about 11 years, a period corresponding, according to certain observers, with that of maximum sun-spots; but what connection exists, if any, between sun-spots and rainfall, is at present a subject merely of conjecture. Whatever this may be, and whether there is really any connection between the two phenomena is, however, apart from our present subject. It is a well-known fact that the destruction of trees does, in some way or another, affect rainfall; but from observations extending over a period of some sixty years, it would appear that, in India, the denudation of forests has not at present caused any appreciable diminution in the average annual amount of rainfall, but the effects of rain are sensibly altered, and many parts of the country have suffered seriously from the destruction of the balance between forest clothed and open tracts established by nature; floods in rivers are of more frequent occurrence, and many rivers, which used formerly to have a perennial flow of water, are now dry, during a portion of the year, especially in their upper reaches.

Although the absolute demolition of all forest growth in a country has ever proved destructive to cultivation and fertility of soil, as in Eastern Spain, Northern Italy, and the desert tracts of Africa and Arabia, it is not at present known what proportion of forest to open country is necessary for the maintenance of a proper and meteorological equilibrium, nor at what point of clearance a retrogade effect is established. There are four separate actions of Nature through which it may be said that forests influence, in some way or other, the physical condition or climate of a country. First, there is a chemical action through the leaves in decomposing the carbonic acid of the air; second, a physical action in retaining moisture in the earth and checking the violence of the wind; third, a physiological action in transmitting to the air, through the leaves, a portion of the moisture which the roots draw from the earth; and, fourth, a mechanical action, through the roots, in retaining in its place the earth, especially on the sides of mountains and hills. A brief examination of these several points will tend to show to what extent forests influence the productiveness of a country, and how they may be considered one of the best safeguards against famines.

Careful observations on these several points have been

made in France, particularly by M. Mathieu, of the Forest School, Nancy, which have led to the conclusion that, while, on the other hand, forests tend to lower the general temperature of a country, and so to promote the fall of rain, at regular intervals and in moderate quantities, on the other hand, they ward off sudden meteorological changes, which are dangerous, inasmuch as they cause sudden and heavy falls of rain, which result in floods and and other like disasters. Experiences in America, and elsewhere, confirm these deductions, and, therefore, insofar as moderate and evenly distributed showers are more conducive to successful farming and certainty of crops, than violent storms and heavy floods, forests generally are conducive to the security of a country against uncertain harvests.

Passing next to the physical action of forests on the air. This may be said to be two-fold; 1st, by preventing the loss of moisture through evaporation and so promoting its absorption by the earth; and 2nd, by acting as a barrier to the violence of storms. It has been ascertained by experimental observation that so great is the protection afforded to the earth in a forest by the leafy canopy which covers it, as well as by the bed of dead leaves on its surface, that only one-fifth of the moisture is lost by evaporation, as compared with the loss by the same action in an unwooded plain; and that this is the case, although a considerably smaller portion of the rain which falls actually reaches the earth. The bed of dead leaves in the forest acts like a sponge, soaking up and retaining the rain and regulating its distribution, or through the roots of the trees, which act like vertical drains, promoting its descent into the lower strata of the earth, there to nourish the springs. More especially in the mountains is the benefit of forests, when they act thus, felt; as the melting of the snow often sets at liberty, within a very short time, a large amount of water, which, if not so caught and absorbed, would run off unprofitably, and often would cause terrible and destructive inundations. Thirdly, forests have a physiological effect on the atmosphere, inasmuch as they withdraw from the soil a certain amount of moisture, a portion of which only is assimilated in the woody tissues of the trees, while the rest is thrown off into the air by the transpiration of the leaves. This, probably, acts as a natural balance to the greater amount of moisture which the presence of a forest retains in the soil; but the phenomena connected with this portion of the subject have been insufficiently studied, and there is but little really known as to the difference between the action of forests through evaporation and that of ordinary field cultivation, nor even as to how far the effects produced may be due to the direct action of the roots as drains, and not as absorbents. Lastly, as to the mechanical effect of the roots of trees in retaining the soil in position, especially on the sides of mountains and valleys, and so in preventing their denudation. The works of the French Forest Department, in the Hautes and Basses Alpes, are now generally cordially acknowledged even by their former most sturdy opponents. So great were the devastations from which these Alpine districts suffered through the denudation of the mountain sides and the consequent formation of torrents, that intervention of the most prompt description became necessary to prevent the destruction not only of the grazing grounds on the hill-sides, but of the rich valleys below them. The French Government has now, at a vast cost, undertaken the replanting and regrassing of these mountains on a most extended scale, and many thousand acres are every year being placed out of danger by the works undertaken. Already the beneficial effect of what has been done is felt in the diminution of the violence of the torrents, and, as the trees grow up, the benefit will be far more widely felt. It may be observed that during the summer of 1875, when so much mischief was done in the south of France by inundations, the Durance, which rises in the mountains east of Avignon, and which on former occasions had been the worst and most dangerous of all the rivers in the south of France, on account of the inundations it had caused, was scarcely heard of, and it was around the head waters of this river that the chief plantation works had during the preceding ten years been carried on.

To assert that the recent famine in India, and the present famine in China, entirely owe their origin to a neglect of ordinary administrative precaution of protecting the forests of the country from destruction, or the wholly inefficient efforts to counteract the evils already done by their destruction in former years, would be to ignore the fact that meteorological disturbances do take place periodically, by which the rainfall of every country is more or less affected; but we have already shown that the effects of these disturbances may be very considerably modified by a due attention to the experiences already gained with reference to the influences of forests upon climate and rainfall. Had both India and China been properly supplied with a due proportion of forest grown, the almost total absence of water in the irrigation tanks of the one, and in the water high-ways of the other, at a period when its presence would have been the cause of considerable mitigation in the severity of the visitation at the very least, might have been avoided; but the canals of China were found not to have sufficient water in them to convey food to the famine stricken districts, whilst no other means of communication were available, and the irrigation tanks in India, upon which so vast a proportion of the cultivated area of the country depends, were dried up at the critical moment when water was required to prevent the total loss of crops, and even the wells became considerably diminished in their powers for irrigation in consequence of the lowering of their water level, and in some instances they too dried up. It has also been observed, especially in Southern India, that several mountain and hill streams which were formerly perennial, and afforded constant supplies to minor irrigation works, have now water in their channels for a portion of the year, for a short time after the cessation of the rains, but that they run dry very rapidly, and possess no water at the very time when it is required for cultivation. These effects are clearly traced to the denudation of the forest tracts which formerly existed in the upper parts of the watersheds of the Indian rivers, and they were noticed particularly by Sir Richard Temple as one of the influences to which the recent famine in Southern India might trace its origin.

THE *New York Herald* STORM WARNINGS.—These storm warnings are now well known in this country, and have proved themselves so effective that they have conquered popular scepticism, and are now a recognised institution. We owe them to the public spirit of Mr. James Gordon Bennett, the enterprising proprietor of the *New York Herald.* They are founded on the general laws of Atlantic storm movements, deduced from a long and laborious examination of ships' logs and weather reports. From these it appears that nearly every storm which strikes the western coasts of Scandinavia, Britain, France, and Spain, has likewise passed over or started from some portion of the United States or Canada. They generally strike Europe to the north of the Bay of Biscay, and travel in a north-easterly, easterly, or south-easterly direction. Our south-easterly winds are usually of equatorial origin, and issue from the Gulf of Mexico; but sometimes a gale from the north-east of America will bend southwards in the Atlantic, so as to strike the British coasts from the south-west. The course of the storms across Europe is commonly over Norway to Northern and Central Russia, over Denmark to Northern Germany or Southern Russia, or over the English Channel to France and the Netherlands, Central Europe, the Valley of the Danube, and Asia Minor. From a review recently issued by the *Herald*, it appears that out of forty-six warnings given last year, which was the first year in which they were issued, only two were unfulfilled. Thirty-one were in every respect correct, eight were correct generally, five were partially borne out by the arrival of gales on parts of the European coasts, as if the main body of the storm had spent itself, and only portions of it remained. It should be mentioned however, that a similar examination of the warnings by Mr. Scott Russell, in England, showed that only twenty per cent. had been fully realised, and twenty-five per cent. partially so, making forty-five per cent. in all.

A CLUE TO SUBTERRANEAN WATER-COURSES.—It appears that the river Danube, near its source in the Black Forest, has a subterranean communication with the neighbouring river Aach, nine miles distant, by means of cracks in its bed. In the dry season, when the level of the stream is low, the water which disappears by this subterranean channel is felt by the mill-owners on its banks as a serious loss, and they recently attempted to stop up the cracks. This action was objected to by the millowners on the Aach, who held that if it were done, there would be a serious deficit of water. To decide whether there was really a communication between the two streams, salt was thrown into the Danube, and it was found that the Aach waters thereafter became brackish. A better test, however, was found in fluorescine. One part of fluorescine perceptibly tints 20,000 parts of water. About fifteen gallons were dissolved in the Danube, and sixty hours after the waters of the Aach showed a decided green tinge, which in time became very intense, then faded away again after about twenty-four hours.

PRIMEVAL MAN.—During one of Professor Hayden's recent geological surveys in Arizona, while measuring some of the ancient ruins of the country in the Chaco canon, one of the explorers discovered in the alluvial deposit of the old river bed a layer of pottery fourteen feet below the surface, and ten feet above this, that is four feet from the surface; the foundation walls of buildings. In this spot there are therefore vestiges of three different settlements, and in the lowest, among the broken pottery, has been found a human skull which bears a striking resemblance to the Mexican and other red Indian tribes of central America.

PHOTOGRAPHY ON WOOD.—The method of transferring by photography drawings or sketches to wood blocks for the purpose of engraving has long been known, although attended constantly by technical difficulties, which have occupied the attention of many scientific minds with a view to their removal. The chemical preparations hitherto in use appear to have produced a surface too hard and brittle for engraving purposes. As is frequently the case when many minds are bent in one direction, we hear from all sides news of discoveries which shall obviate all the difficulties. Amongst the best, and we believe the most perfect process, is that known as the "Hentschell process," which has lately been purchased by Mr. John Swain, the well-known mechanical draughtsman and engraver, of the Strand, London. His specimens of drawings and old engravings transferred to wood are marvellous in their faithful exactitude, the finest line of the original being re-produced. The value of this method for securing exact replicas of old prints or engravings direct from the hand of the artist, needs no comment. The process is simply invaluable. The grain or surface of the wood is hardened and prepared for the graver by the processes employed to fix the picture.—*The Journal of Applied Science.*

STANDARDS OF LENGTH.—Standards of length for the use of the public have been set up at the Guildhall, by authority of the City of London Corporation. These consist of the hundred feet and sixty-six feet chain, divided into tens, laid out on the floor of the hall, as well as measures of a yard, two feet, and one foot indicated on the north wall.

STOCKWELL'S SELF-LIGHTING GAS TAP.—By this novel and simple arrangement the mere act of turning the tap ignites the gas. It can be used in connection with the ordinary tap. By means of a spring and propeller an explosive pellet is ignited which produces a flash sufficient to kindle the gas, but not sufficient to set fire to anything less combustible. On turning out the gas the propeller is brought into position for placing another pellet under the spring which explodes it at the proper moment. The pellets are carried forward upon a tape which is stored in a reservoir. When the supply of tape is exhausted a fresh roll can be readily inserted.

VELOCITY OF SOUND IN AIR.—The method of coincidences has recently been applied by M. Szathmari, to determine the velocity of sound in free air, as follows:—A pendulum, whose rate was accurately known, closed at each passage through the vertical position, a battery circuit, the line of which was 220 m. long; and included two electric bells. When both bells are placed before the observer, he hears them simultaneously. If one be moved a little way off this simultaneity ceases; and if the bell be moved still further a point is reached, at which both bells are heard simultaneously again. The distance is that through which the sound moves in the interval between two successive ringings of the bells. The pendulum, in the present case, had a period of 0·2961 seconds; the distances at which the sounds of the two bells were heard at once were directly measured, and the average value (from thirty measurements) was 99·25 metres. From this the velocity of sound in free air = 335·19 m. Reducing the value to that for dry air at zero the number obtained is 331·5 m. This lies about midway between Regnault's values (330·7) and that of Moll and Van Beck (332·26).—*Nature.*

NEW METHOD OF DETERMINING TEMPERATURES.—This method (which is due to M. E. Dragoumis) consists in using two thermometers, one at a higher, and the other at a lower temperature than that of the body to be tested. On bringing the two thermometers into contact with the body, the mercury will fall in one, and rise in the other. The point at which the two columns coincides is the true temperature of the body, supposing the instruments to be accurate.

City Notes.

Old Broad Street, May 29th, 1878.

DURING the past fortnight there has been very little stirring in the city of interest to those who read these notes. Dullness has continued to prevail in Capel Court, and the dullness on the Stock Exchange has been reflected in every circle of commercial activity. Touching the scare which took place the other day amongst holders of Atlantic Cable shares, in consequence of a rumour that a new competition line was on the cards, we may remark that, though it has temporarily subsided, no well informed person supposes that the report was merely an idle canard. The very fact that the cable belonging to the Direct United States Company has been successfully duplexed, offers an encouragement to enterprising capitalists, while if it be correct—and we have very good authority for believing as much—that the Direct Cable can now perform the whole message carrying of the Atlantic, if another independent cable were laid and likewise duplexed, even the gentlemen who originated the scheme for the amalgamation of the Anglo-American and Direct Companies will not venture to deny that it would be found an exceedingly powerful opponent to the existing cables. With a low tariff, a new Atlantic Cable Company, well managed, might, in brief, carry everything before it at this juncture. To us it appears a pity that the existing companies should positively court opposition by adhering to the higher tariff. Do the directors of these companies think that if the competition they at length confessedly dread comes to pass it would be possible for them to maintain the tariff? Would the public be satisfactorily impressed by the assurance that whereas a new cable might be defective, the old one had been well tested, and it was better to pay a higher rate for a certainty? Hardly. And this mode of argument would also cease to be of force, when the cable belonging to the new company had been proved a success.

We are aware that the directors of the existing companies may reply that, if the tariff were lowered, the reserve funds could not be sufficiently increased and a reasonable dividend paid, and here, in truth, is their dilemma. If, as we have pointed out, they persist in the higher scale of charges in the face of formidable opposition, they must inevitably lose some of their custom; if, on the other hand, they retain their customers by adopting the lower scale, they run the risk of carrying on business, not perhaps at an absolute loss, but at a very insignificant profit. Thus, it may be hoped, the existing companies will see the unwisdom of much of their policy in the past; they may not suffer from it as we have indicated, but it is equally possible that they may. Until there is a revival in the money-market, nothing definite respecting a new enterprise may be announced; but should the Eastern Question be disposed of without war, there will, no doubt, be an immediate improvement in commercial affairs everywhere, and investors will be as ready as ever to respond to schemes which are marked by ability, caution, and straightforwardness.

The Secretary of the Eastern Extension Telegraph Company, referring to mention being made of the Government of Victoria only in connection with the duplication of the company's cables in the East, explains that the proposals of the company were not accepted by any government in particular, but by the Telegraphic Conference which recently sat in Melbourne, on behalf of the combined governments of Australasia.

We observe from the annual report of Reuter's Telegram Company, Limited, that a further dividend of 5 per cent., making 7½ per cent. for the year, is now payable, and after adding £2,000 to the reserve fund, there remains a balance of £205 to be carried forward.

If by the acceptance of Sir Edward Watkin of the chairmanship of the East London Railway Company, the Metropolitan line of railway will be actually brought into connection with the East London line, then, we should say, there is one very good reason, at least, why the shareholders of the East London desire, as we believe they desire, his appointment. It is true that there is a covered way of communication between the Great Eastern station in Liverpool Street, and the Metropolitan station close to. But the lines should join each other, for many people somehow do not, or will not, see covered ways of communication. As to the general prospects and position of the East London Company, the latter is not by any means cheerful; the former can scarcely be said to be bright. Yet we admit that "It is never too late to mend," may be fitly observed in reference to the management of the East London Railway Company. Things have not gone on well, but there is a worse state possible to the company. We do not always agree in the adulation which is offered to Sir Edward Watkin—although he is a great railway authority and chairman of several companies, he is like other mortals open to make blunders, and he has blundered—but we do think that if he accepts the chairmanship of the East London Railway Company, the shareholders will soon find that there may be a possibility of a dividend, even for them.

THE TELEGRAPHIC JOURNAL.
VOL. VI.—No. 129.

TELEGRAPHISTS AT FOREIGN STATIONS.

WE publish in this number the unpersonal portions of a lengthy communication which we have received from a "West Indian Telegraphist." We have published it, not from any desire to ventilate a particular grievance, but in the belief that some of its statements may have a bearing on the submarine telegraph service in general which may be productive of good. Whether our correspondent be a "man with a grievance" or not, we do not know; but we think that there is a great deal of truth and good sense in parts of his letter. At any rate he has a right to be heard, and our columns are always open as a medium of expression for telegraph *employés*.

We have in a former article treated of several points in the management of the submarine service which are indicated by a "West Indian Telegraphist." It is our intention at present to confine ourselves to a consideration of the state of comfort and morality which exists at telegraph stations abroad. In too many cases these blessings are most conspicuous by their absence.

A young operator entering the submarine telegraph service at once becomes the tool of his company, and receives orders to betake himself to some foreign station. Arrived there he goes into quarters with the rest of the clerks, and duly takes his eight hours' shift of signalling. The company provide his quarters, which are sometimes even wretched, if not beastly, although in general they are tolerably comfortable as far as the needs of mere animal existence—shelter, meals, and sleep—are concerned. The company also exact their stated amount of office routine from him; but here their solicitation for his welfare too frequently ends. The youth is left to seek his own amusements and recreation. He finds his bare quarters dull, the jokes of his companions are stale, time hangs heavy on his hands; so he goes out into the streets to smoke cigarettes, or take drinks at a *café* or *alcazar*. His social circle is of the smallest, if a real social circle exists for him at all; so in default of something better he seeks the female companionship which the streets never fail to offer. Severed from home, and all the upholding ties of kindred, deprived of good literature, pure society, and sometimes even of the church, his situation and prospects forbidding marriage, his work mechanical routine, himself the machine of a company, the unimportant limb of a system, feeling himself unsettled and a nomad, can it be wondered at that he yields himself to the influences around him, and lapses into motiveless ease and immorality?

We think that, if there be any remedy for the discomforts and immorality of foreign telegraph stations, it should proceed from the directory of the company and permeate downwards. It is very unlikely that the needed reform will emanate from the clerks themselves and spread upwards. It is high time that the management of telegraph companies ceased to regard their *employés* as mere manipulating instruments. This iron doctrine of our utilitarian times will not pay in the long run. If operators are treated with the consideration due to gentlemen, they are the more likely to prove such, and the resulting gain in harmony and good feeling is certain to prove more profitable to the company in the end. The directors of a company, and the superintendents under them, and by their orders, ought to see that the clerks are not only housed and fed, but they should take pains to provide wholesome and improving amusements also. Housing and feeding are the lowest essentials of life; and a telegraph company, sending young men and youths abroad to strange and out-of-the-way places and detaining them, should recognise that it takes upon itself a charge of far more moment than food and shelter. A life of this kind is exceptionally trying to the moral character of any man, and especially young men, some of whom are not so wise as they might be, and it is right that the company should do what is in their power to ameliorate its dangers. Some companies treat their servants better in this respect than others. Billiard tables are provided at some stations, and one or two periodicals circulated. Our plea is for something more elevating than billiard tables. Billiard tables are very well so far, but they are not enough, although to say so may astound the directorial mind to a degree only paralleled in the case of Mr. Bumble when the audacious Oliver Twist asked for more soup. Telegraph directors may find it difficult to believe that a telegraph operator can possibly require amusement of a higher kind than billiards; but such is the hard fact, nevertheless, and it must be faced. Pure literature and family society are, next to the church, the two most potent safeguards for a youth against the easy descent into immorality. If the directory of a telegraph company would interest itself in this subject, and see that a good, if small, library was provided at each station, and that the intercourse of clerks with the available good society of the place was cordially promoted, we feel sure that good would come of it. A literary and debating society, under the presidency of the superintendent,

and a corps of experimenters, would also tend to breathe life and freshness into the noxious vapours of jealousy, discontent, and apathy, which too commonly form the social atmosphere of a station as things are at present. We are of opinion, too, that some provision should be made for enabling operators to marry—a consummation quite discountenanced by the exigencies of the existing *régimes*. To effect this the more easily, only the younger men might be sent to outlandish and desert stations, the married operators being allowed to stay in towns and cities. A prospect of this kind before an operator would not fail, we think, to make him more contented with his lot, to inspirit him in his career, and to improve his character.

We have sufficient faith in the directors of the companies as to believe that it is only necessary to make them aware of the deficiencies of their station arrangements and the real needs of their servants, to secure measures of remedy from them. Unfortunately they are so placed as not to see for themselves what is taking place at their stations. Occasionally a pilgrimage is made by some of them through the latter; but it is not difficult to understand that in this way they see matters at their best, just as at a school inspection, where all the torn pinafores are mended, and the pupils faces shining. At all events, until some change for the better is made in the comfort and diversions of the operators at foreign stations, so long will the submarine telegraph service remain a kind of slow-grinding devil's mill for the demoralisation of young men.

THE MICROPHONE AS A RECEIVER.

[Abstract of a paper read before the Royal Society of Edinburgh on 3rd June, 1878, by JAMES BLYTH, M.A., F.R.S.E.]

THE following experiments were suggested by a description of the microphone lately invented by Professor Hughes. Instead of the pointed piece of carbon supported between two pieces of the same material, it occurred to me that gas cinders were likely to answer the purpose tolerably well. To test this I included in the circuit of an ordinary telephone a single Leclanchè cell, and a small jelly jar half filled with gas cinders broken into rather coarse fragments. The connections were made by slipping down, at opposite sides, between the cinders and the sides of the can, two strips of tin to which the circuit wires were attached. When this simple instrument was used as a transmitter, articulate sounds were rendered very loud and distinct in the distant telephone, though occasionally marred by what appeared to be the rattling of the cinders in the can. With this transmitter, sounds were also quite audible even when the speaker stood several yards away from it.

In my next experiment I took a shallow box of thin wood, about 15 in. by 9 in., and filled it with cinders, taking care, in the first place, to nail to the inside of its ends two pieces of tin to which wires could be attached. Having nailed down the thin lid of the box, and included it in the circuit of a telephone, along with a Leclanchè cell, I found that it acted both as a very sensitive microphone, as well as an excellent transmitter for the telephone. With three of these boxes hung up, like pictures, on the walls of an ordinarily-sized room, and connected in circuit, almost every kind of noise made in any part of the room was revealed in the telephone. Speaking was heard distinctly, and a part song by two voices in the middle of the floor was rendered with surprising clearness and accuracy.

In the next experiment, still using the same cell in the circuit, I tried as transmitter a single elongated cinder, with the wires wound tightly round each end. Sounds uttered close to this cinder were quite audible; but I failed to hear them when I substituted for the cinder the carbon of a Bunsen cell, with brass clamps firmly attached to each end, into which the circuit wires were screwed.

I next removed the Leclanchè cell from the circuit, and used as transmitter the jelly jar containing dry cinders. I sometimes fancied that I heard sounds even with the cinders dry, but they become distinctly, though faintly, audible as the cinders become somewhat moistened by the breath of the speaker. On pouring water into the jar, so as almost to cover the cinders, the sounds were heard in the telephone almost as distinctly as when the Leclanchè cell was in circuit. I did not, however, hear any sound with the cinders removed and water only in the jar, not even when the water was made a better conductor by being slightly acidulated.

In the next experiment I tried if the jar with the cinders would act as a receiver, as well as a transmitter, and was not a little surprised to find that it did so. For this purpose I used similar jars of cinder, both for transmitter and receiver, and included a battery of two Groves' cells in the circuit. Articulate sounds uttered in the one cinder jar were distinctly heard in the other, and even voices could be distinguished. Here we have a result which, as far as I know, is quite new, and which renders it quite possible to have an effective telephone worked entirely by the electric current without the aid of magnetism. From some experiments I have recently made, it appears that the loudness of the sounds depends upon the strength of the current in the circuit; and I have no doubt but that excellent telephones can be made in this way, when proper forms, both of transmitter and receiver, are adopted. I have also tried successfully an ordinary telephone as transmitter and a cinder jar as receiver, but in this case the sounds were somewhat fainter and less easily distinguished.

THE PHONOGRAPH AND VOWEL SOUNDS.

AT the same meeting of the Royal Society of Edinburgh, Professor Fleeming Jenkin and Mr. J. A. Ewing made a second communication on the wave forms of articulate sounds, as investigated by help of the phonograph. They had obtained about 200 greatly magnified copies of the tinfoil records, chiefly for the sounds *o* and *oo*, and had

already subjected more than sixty of these to harmonic analysis, extending as far as the sixth partial tone. The results for *o* were consistent with the theory of Donders and Helmholtz, that the vowel quality is given by the reinforcement caused by a constant, or nearly constant, mouth-cavity; this reinforcement extends, however, over a wide range of pitch. The results for *oo* did not seem to be consistent with a constant-cavity theory.

ELECTRIC TELEGRAPHY AT THE UNIVERSAL EXHIBITION OF 1878.

By LE COMTE DU MONCEL.

ELECTRIC telegraphy figures this year in the Paris Universal Exhibition in class 65, and occupies in the French Section an important place in the machinery annex. In the foreign sections electric and telegraphic apparatus, sufficiently rare, by the way, are scattered over various places without any very well defined position, and most frequently in the machinery gallery. We are astonished at the want of order which this year characterises the classification of these important and curious productions.

Without any impartiality, we can say that the French exhibition of telegraphy has this year distinguished itself, and in it are to be found almost all the important models of telegraphs which have been devised in different countries, and which have, moreover, all been tested or employed, more or less, by the French telegraph administration—not only several types of the beautiful multiple telegraphs of Meyer and of Baudot, but also the duplex systems of Stearns, Ailhaud, Mercadier, applied to the Morse and the Hughes; the quadruplex of Le Sieur; the printers of Hughes, D'Arlincourt, Dujardin, Chambrier; the automatic printers of Olsen and Girarbon; Wheatstone's automatic and fast-speed Morses; submarine reflecting telegraphs; the autographic systems of Meyer, Lenoir, D'Arlincourt; the more or less modified forms of Morse, of MM. Cacheteaux, Hequet, Fridblatt, Rault, Chassau, &c., the relays and translators of MM. D'Arlincourt, Tommasi, Meyer, &c., dial telegraphs of diverse forms; lightning-guards, switches, bells and calls of very varied forms and systems.

I have explained in my *Exposé des Applications de l'electricité* the greater part of these systems, and most of them are known to the readers of the *Telegraphic Journal*, from the descriptions of them which have been given in this journal. However, we think we should give some details concerning the multiple telegraph of M. Baudot, which although in its infancy has already given highly important results. It has been possible, in fact, in the six months during which this system has been experimented upon on the Paris-Bordeaux line to transmit as many as two hundred messages per hour, and that without any more employés than are required for the "fast-speed" Wheatstone, which transmits only eighty-five or ninety at most upon this length of line.

The system of M. Baudot belongs to the category of instruments based upon the algebraical combination of simple signals, few in number; and that one may at once recognise its advantages and principle, it is only necessary to consider the time lost in ordinary transmissions by the Hughes' telegraph, and the facility offered by combined simple signals for utilising this lost time.

Let us divide, mentally, into thirty-one intervals, the half second required by the type-wheel of a Hughes printing telegraph to accomplish its revolution. It is clear that if we have the letter A to transmit, we shall only require for its impression a single one of these intervals of time; but for the letter Z we require twenty-eight; so that in the first case we lose no time, while in the latter we lose $\frac{27}{28}$ of the duration of a revolution of the type-wheel. Thus, if by any convenient combination of currents, we could arrange that all the letters of the type-wheel, whatever their alphabetical order, could be printed in the same time, which could then be very brief, we could employ the time served for other transmissions, and at each turn of the type-wheel several letters could be transmitted through the agency of several *employés*; but, as will readily be understood, it would be necessary for this that these combinations of currents should leave, upon a special translating instrument for each *employé*, durable traces of the signal sent, and that these traces should be capable of operating the printing mechanism at the moment that the type-wheel presented to the printing mechanism the letter corresponding to the signal sent. We should also require that a current-distributor should, during each revolution of the type-wheel, transmit the current successively through the different manipulators actuated by the *employés*.

To obtain this complex result, M. Baudot started with the well-known principle, already applied by several physicists, notably by MM. Wheatstone, Morse, Highton, Whitehouse, &c., that with five simple elementary signals, one can obtain by their combinations, one to one, two to two, three to three, &c., thirty-one composite signals which can represent all the letters of the alphabet, and even the figures and other signals most generally employed in telegraphy, adapting to the printing mechanism the transmutator system of Hughes. By this means he was able, therefore, with five successive emissions of current at most, to obtain upon five polarised relays, a durable representation of every letter of the alphabet he wished to transmit; and this transmission required but $\frac{5}{28}$ of the time taken up in one revolution of the type-wheel. These emissions could, moreover, be effected by means of five Morse keys placed under the fingers, and their succession could be mechanically controlled by a distributor travelling synchronously with the type-wheels. And, further, this distributor performing its revolution in one half second, could, as in the multiple system of M. Meyer, be made to present several series of quintuple contacts, each appropriated by a special *employé*; and the number of these series would be limited only by the maximum number of signals capable of being printed during one revolution of the type-wheel. With the ordinary speed of the Hughes, calculation showed that the number of these series might be seven, but M. Baudot makes use of five only, reserving the time which might have been devoted to the other two for the preparation of the signal to be transmitted. With this system, therefore, it is

possible to print ten letters per second, that is, 100 words per minute, or 300 messages per hour; but in reality the speed obtained is somewhat less than this, by reason of the time lost and the multiplicity of contacts, which causes the duration of current necessary for the impression of a signal, to be longer than it theoretically should be.

For the realisation of all the effects above described, the apparatus is composed of six different pieces of mechanism: 1. Five manipulators of five contacts each, distributed over two sides of a large table in the centre of which are placed the printers and other mechanism. 2. A universal distributor and a mechanical corrector for synchronism controlled by a vibrating spring similar to that of M. Hughes. 3. Five relays with quintuple electro-magnets, which represent the translating receivers already alluded to. 4. Five combinators destined to convert the signals transmitted on the translators into local-circuit combinations capable of operating the printing mechanism at the moment when the letters representing these signals are presented before corresponding printers. 5. Five printing receivers connected mechanically with the combinators, which print the message under the influence of the combinations effected by the letter. 6. A mechanical motor, periodically regulated, which drives the receivers and combinators.

In a future article we propose to describe these various parts; but we should here remark, that the system has been recently simplified by M. Baudot; and among the exhibits of M. Dumoulin-Froment, is to be found a specimen of the new model which requires a much smaller number of electrical parts. In the one we have been speaking of there are no fewer than thirty-one electro-magnets; in the latter there is but one, on the other hand the mechanical actions are more complicated and more delicate.

Meyer's multiple telegraph is now well-known, and is employed in different countries. It has everywhere given excellent results, and we are surprised that it has not been more extended. There are two specimens of it in the exhibition, one arranged for six transmissions, which appears in the display made by the French Telegraph Administration, the other arranged for eight transmissions, which is found among the exhibits of M. Hardy, the clever constructor of this apparatus.

(To be continued.)

ELECTRO-DYNAMIC QUALITIES OF METALS.—EFFECTS OF STRESS.

By SIR WILLIAM THOMSON, F.R.S., Professor of Natural Philosophy in the University of Glasgow.

(Abstract.)

THIS paper commences with a detailed description of a series of experiments on the effects of stress on the magnetism of soft iron, of which some first results were described in a preliminary notice, communicated to the Royal Society on the 10th of June, 1875, and published in the "Proceedings." A few months later, the author found that he had been anticipated by Villari* in the most remarkable of those results—that showing increase or diminution of magnetisation by longitudinal pull, according as the magnetising force is less than, or greater than, a certain critical value.

In the first series of experiments described in this paper, the amount of the magnetising force is varied through a range of values from zero to 900, on a scale on which about 12½ is the value of the vertical component of the terrestrial magnetic force at Glasgow, and the effects of hanging on and taking off weights of 7-lbs., 14-lbs., and 21-lbs.,† in changing the induced magnetism, are observed. The experiments were made at ordinary atmospheric temperatures, and at temperature 100° C. The results are shown in curves, of which the abscissæ represent the magnetising forces and other ordinates, the change of magnetism produced by "ons" and "offs" of the weight while the magnetising force is kept constant. The Villari critical value was found to differ for the two temperatures, and for different weights, thus approximately:—

Amount of weight "on" and "off."	Magnetising force for which the "on" and "off" produce no change of magnetism.	
	At atmospheric temperature (being about 15° C.)	At temperature 100° C.
7 lbs.	266	280 or 290
14 „	281	286
21 „	288	310

The maximum effect of the "on" and "off" was found in each case with magnetising force of from 50 to 60 of the arbitrary scale divisions (or about four times the Glasgow vertical force). Its amount differed notably, though not greatly, with the temperature, and, as was to be expected, greatly with the different amounts of pull; but it was not nearly three times as much with 21 lbs. as with 7 lbs.; thus approximately:—

Amount of weight "on" and "off."	Maximum effect in the way of augmentation of magnetism by "on" and diminution by "off."	
	Temperature about 15° C.	Temperature 100° C.
7 lbs.	31 scale divisions of ballistic galvanometer.	25 scale divisions.
14 „	35 do. do.	32·4 do do.
21 „	54 do. do.	50·3 do. do.

The curves all tend to asymptotes parallel to the line of abscissæ on its negative side for infinite magnetising forces; and they indicate the following ultimate values for the two temperatures, and the different amounts of pull:—

* Poggendorf's "Annalen," 1868.

† The wire was of about 22 Birmingham gauge, weighing therefore about 14-lbs. per nautical mile. It was so soft that it had experienced a considerable permanent stretch by 21-lbs.; it would probably break with 30 or 40-lbs. Steel pianoforte wire of same gauge bears about 230-lbs.

Amount of weight "on" and "off."	Effect in the way of diminution of magnetism by "on" and augmentation by "off" when the magnetising force is very great.	
	Temperature 15° C.	Temperature 100° C.
7 lbs.	6 scale divisions of ballistic galvanometer.	3 scale divisions.
14 "	13·5 do. do.	9·2 do. do.
21 "	21 do. do.	15·2 do. do.

For other features the curves themselves as given in the paper may be looked to.

Later experiments on the effects of pull transverse to the direction of magnetisation showed correspondingly *opposite* effects to those of longitudinal pull, but with a "critical value" of magnetising force nearly twice as great. That for longitudinal pull, according to the preceding figures, was about 23 times the Glasgow vertical force; for the transverse pull the critical value found was about 60 times the Glasgow vertical force. The transverse pull was produced by water pressure in the interior of a gun-barrel applied by a piston and lever at one end. Thus a pressure of about 1,000 lbs. per square inch, applied and removed at pleasure, gave effects on the magnetism induced in the vertical gun-barrel by the vertical component of the terrestrial magnetic force, and, again, by an electric current through a coil of insulated copper wire round the gun-barrel, which were witnessed by the audience. When the force magnetising the gun-barrel was anything less than about 60 times the Glasgow vertical force, the magnetisation was found to be less with the pressure on than off. When the magnetising force exceeded that critical value, the magnetisation was *greater* with the pressure on than off. The residual (retained) magnetism was always less with the pressure on than off (after ten or a dozen "ons" and "offs" of the pressure to shake out as much of the magnetisation as was so loosely held as to be shaken out by this agitation).

The vertical component of the terrestrial magnetic force at Glasgow is about ·43 c.-g.-s. units. Hence the critical values of the magnetising force for longitudinal and transverse pull are approximately 10 and 25 c.-g.-s. units. With any magnetising force between these limits the effect of pull whether transverse or longitudinal must be to diminish the magnetisation. Hence it is to be inferred that equal pull in all directions would diminish, and equal positive pressure in all directions would increase, the magnetisation under the influence of force between these critical values, and through some range above and below them; and not improbably for all amounts, however large or small, of magnetisingforce; but further experiment is necessary to answer this question.

The opposite effects of longitudinal and transverse pull, for magnetising forces not between the critical range of from 10 to 25 c.-g.-s. units, show an aeolotropic magnetic susceptibility in iron under aeolotropic stress [that is, any stress or other than pressure (whether positive or negative) equal in all directions]. Consideration of the relation of this result to Wiedemann's remarkable discovery of the induction of longitudinal magnetisation by twisting an iron wire through which an electric current is maintained, is important and suggestive. In the present paper counter-influence is pointed out, in the aeolotropic change of electric conductivity probably produced in the iron by the stress. This influence illustrated by experiments made a few days ago by the author, by Mr. Macfarlane, in Glasgow, and Mr. Bottomley, in the Physical Laboratory of King's College, London, by kind permission of Professor Adams, which shows in two very different ways that twisting a brass tube through which a current of electricity is maintained gives to the electric stream lines a spirality of opposite name to that which the twist gives longitudinal filaments of the substance, and so proves that in aeolotropically stressed brass the electric conductivity is greatest and least in the directions of greatest and least pressure. The same law probably holds for iron. Wiedemann's result is that the end of the iron wire by which the current enters, becomes a true north or a true south pole, according as the twist is that of a right handed or of a left handed screw. This is the same direction of effect as would result from the aeolotropy of the magnetic susceptibility produced by the stress of the tangential magnetising force in the outer part of the wire is less than the critical value, for which the effect of the stress is isotropic; but it is opposite to the effect due to the aeolotropy of the electric conductivity. Yet the same author in repeating Wiedemann's experiments has found his result—the same in direction, and greatest in amount—with the strongest currents he has hitherto applied—currents strong enough to heat the wire seriously (but not yet measured or estimated in absolute measure). The reconciliation of the Wiedemann result with the conflicting influence of conductive aeolotropy, and with the influence of aeolotropy of magnetic susceptibility, which also is conflicting when the magnetizing force is great enough, is a difficulty which calls for investigation.

The paper includes a series of experiments on the effects of twist on magnetisation of iron wire under longitudinal magnetising force (the Glasgow vertical force alone in this first series). Results of previous experimenters, Matteucci, Wertheim, and Edward Becquerel, according to which twist in either direction diminishes the magnetisation, and extends them to wires under different amounts of longitudinal pull. When the pull was great, approaching the limit of elasticity of the wire, the twist, even when well within the limits of elasticity, had much less effect in diminishing the magnetism than when the pull was small. The results are recorded in curves which show a very remarkable lagging of effect, or residue of influence depending on previous conditions.

The paper concludes with a description of experiments, showing in bars of nickel and cobalt effects of longitudinal pull opposite to those found by Villari for iron with magnetising force below the critical value—that is to say, the magnetisation of the nickel and cobalt was diminished by pull. But this effect came to a maximum, and began to diminish markedly as if towards zero, when the magnetising force was diminished. Hitherto the critical value, if there is one, has not been reached; but the experiments are being continued to find a reversal of the effect, if it is to be found, with attainable degrees of magnetising force.—*Proceedings of the Royal Society.*

THE PHONOGRAPH AND ITS FUTURE.

By T. A. EDISON. *

OF all the writers' inventions, none has commanded such profound and earnest attention throughout the civilized world as has the phonograph. This fact he attributes largely to that peculiarity of the invention which brings its possibilities within range of the speculative imaginations of all thinking people, as well as to the almost universal applicability of the foundation principle, namely, the gathering up and retaining of sounds hitherto fugitive, and their reproduction at will.

From the very abundance of conjectural and prophetic opinions which have been disseminated by the press, the public is liable to become confused, and less accurately informed as to the immediate result and effects of the phonograph than if the invention had been one confined to certain specific application, and, therefore, of less interest to the masses. The writer has no fault to find with this condition of the discussion of the merits and possibilities of his invention: for, indeed, the possibilities are so illimitable, and the probabilities so numerous, that he—though subject to the influence of familiar contact—is himself in a somewhat chaotic condition of mind as to where to draw the dividing line. In point of fact, such line cannot with safety be defined in ordinary inventions at so early a stage of their development. In the case of an instrument of the nature and scope of the phonograph, it is practically impossible to indicate it to-day, for to-morrow a trifle may extend it almost indefinitely.

There are, however, certain stages in the developing process which have thus far been actually reached; certain others which are clearly within reach; and others which, though they are in the light of to-day to be classed as possibilities, may to-morrow become probable, and a little later actual achievements. It is the intention of the writer in this article to confine himself to the actual and the probable, to the end that a clearer conception of the immediate realization of the phonograph may be had. He concedes to the public press and the world of science the imaginative work of pointing and commenting upon the possible. It is in view of the liberal manner in which this has already been done, and the handsome treatment he has received at their hands, that he for the first time appears *in propriâ personâ* to discuss and comment upon the merits of one of his own inventions.

In order to furnish a basis upon which the reader may take his stand, and accept or combat the logic of the writer in his presentment of the probabilities of the phonograph, a few categorical questions are put, and answers given upon the essential features of the principle involved:

1. Is a vibrating plate or disc capable of receiving a complex motion which shall correctly represent the peculiar property of each and all the multifarious vocal and other sound-waves?

The telephone answers affirmatively.

2. Can such complex movement be transmitted from such plate by means of a single embossing point attached thereto, to effect a record upon a plastic material by indentation, with such fidelity as to give such indentations the same varied and complex forms; and, if so, will this embossing point, upon being passed over the record thus made, follow it with such fidelity as to retransmit to the disc the same variety of movement, and thus effect a restoration or reproduction of the vocal or other sound-waves, without loss of any property, essential to producing upon the ear the same sensation as if coming direct from the original source?

The answer to this may be summed up in a statement of the fact that by the application of power for uniformity of movement, and by attention to many seemingly unimportant and minor details, such as the *form* and material of the embossing point, the proper *damping* of the plate, the character of the material embossed, the formation of the mouthpiece over the plate, &c., the writer has at various times during the past week reproduced the waves with such degree of accuracy in each and every detail as to enable his assistants to read, without the loss of a word, one or more columns of a newspaper article unfamiliar to them, and which were spoken into the apparatus when they were not present. The only perceptible loss was found to be in the quality of the utterance—a non-essential in the practical application of the apparatus. Indeed, the articulation of some individuals has been very perceptibly improved by passage through the phonograph, the original utterance being mutilated by imperfection of lip and mouth formation, and these mutilations eliminated or corrected by the mechanism of the phonograph.

3. Can a record be removed from the apparatus upon which it was made, and replaced upon a second without mutilation or loss of effective power to vibrate the second plate?

This is a mere mechanical detail, presenting no greater obstacle than having proper regard for the perfect interchangeableness of the various working parts of the apparatus—not so nice a problem as the manufacture of an American watch.

4. What as to facility of placing and removing the record-sheet, and as to its transportation by mail?

But ten or fifteen seconds suffice for placing or removal. A special envelope will probably be required for the present, the weight and form of which, however, will but slightly increase the cost of postage.

5. What as to durability?

Repeated experiments have proved that the indentations possess wonderful enduring power, even when the reproduction has been effected by the comparatively rigid plate used for their production. It is proposed, however, to use a more flexible plate for reproducing, which, with a perfectly smooth stone point, diamond or sapphire, will render the record capable of from 50 to 100 repetitions, enough for all practical purposes.

6. What as to duplication of a record and its permanence?

Many experiments have been made, with more or less success, in the effort to obtain electrotypes of a record. This work has been done by others, and, though the writer has not as yet seen it, he is reliably informed that, very recently, it has been successfully accomplished. He can certainly see no great practical obstacle in the way. This, of course, permits

* From *The North American Review*, May-June, 1878.

of an indefinite multiplication of a record, and its preservation for all time.

7. What are the requisite, force of wave impinging upon the diaphragm, and proximity of the mouth to the diaphragm to effect a record?

These depend in a great measure upon the volume of sound desired in the reproduction. If the reproduction is to be made audible to an audience, considerable force is requisite in the original utterance; if for the individual ear, only the ordinary conversational tone (even a whisper has been reproduced). In both cases the original utterances are delivered directly in the mouth-piece of the instrument. An audible reproduction may, however, be had by speaking at the instrument from a distance of from two to three feet in a loud tone. The application of a conical tube or funnel to collect the sound waves, and the construction of an especially delicate diaphragm and embossing point, &c., are the simple means which suggest themselves to effect this. The writer has not as yet given this stage of the development much attention, but sees no practical difficulty in gathering up and retaining a sectional part of the sound waves diffused about the original source within a radius of, say, three feet (sufficiently removed not to be annoying to a speaker or singer).

(To be continued.)

PROFESSOR CLERK-MAXWELL ON THE TELEPHONE.

ON Friday, May 24th, a large audience filled the Senate House to hear the Rede Lecture, the lecturer being Professor Clerk-Maxwell, and the subject "The Telephone." The Vice-Chancellor presided, and introduced the lecturer, who delivered his discourse to the following effect:—

The telephone is so simple in construction that I have not yet met anyone acquainted with the first elements of electricity who has experienced the slightest difficulty in understanding the physical process involved in its action.

It would be as useless as it would be tedious to try to explain the various parts of this small instrument to persons in every part of the Senate House. I shall, therefore, consider the telephone as a material symbol of the widely separated departments of human knowledge, the cultivation of which has led, by as many converging paths, to the invention of this instrument by Professor Graham Bell.

For whatever may be said about the importance of aiming at depth rather than width in our studies, and however strong the demand of the present age may be for specialists, there will always be work, not only for those who build up particular sciences and write monographs on them, but for those who open up such communications between the different groups of builders as will facilitate a healthy interaction between them.

We shall begin with the telephone in its most obvious aspect, as an instrument depending on certain physical principles.

The apparatus consists of two instruments, the transmitter and the receiver, doubly connected by a circuit capable of conducting electricity. The speaker talks to the transmitter at one end of the line, and at the other end of the line the listener puts his ear to the receiver, and hears what the speaker says.

The process in its two extreme stages is so exactly similar to the old-fashioned method of speaking and hearing with the speaking tube, that no preparatory practice is required on the part of either operator.

In the electric telephone there is a medium extending from the one instrument to the other. It is a copper wire, or rather two wires forming a closed circuit. But it is not by any motion of the copper that the message is transmitted. The copper remains at rest, but a variable electric current flows to and fro in the circuit.

It is this which distinguishes the electric telephone from the ordinary speaking tube, and from the transmission of vibrations along wooden rods by which Sir Charles Wheatstone used to cause musical instruments to sound in a mysterious manner without any visible performer.

We have to distinguish the principle of the articulating telephone from that of a great number of electrical contrivances which produce visible or audible signals at a distance. Most of these depend on the alternate transmission and interruption of an electric current. In some part of the circuit a piece of apparatus is introduced corresponding to this instrument, which is called a key. Whenever two pieces of metal, called the contact pieces, touch each other, the current flows from the one to the other, and so round the circuit. Whenever the contact pieces are separated the current is interrupted, and the effects of this alternation of current and no current may be made to produce signals at any other part of the circuit.

In the Morse system of signalling, the rate at which currents succeed one another depends on the rate at which the operator can work the key; if this rapidity of succession is by any means very much increased, the ear ceases to distinguish separate signals, but begins to recognise the impression it receives as that of a musical tone, the pitch of which depends on the number of currents in a second.

Tuning forks, driven by electricity, were used by Helmholtz in his researches on the vowel sounds, and whenever we have occasion to follow the march of a process which takes place in a short time, such as the vibration of a violin string, the tuning fork becomes our appropriate timepiece.

Apparatus of this kind, however, the merit of which is its regularity, is quite incapable of adapting itself to the transmission of variable tones such as those of a melody.

The first successful attempt to transmit variable tones by electricity was made by Philip Reis. On October 21, 1861, Reis showed his instrument, which he called a telephone, to the Physical Society of Frankfort-on-the-Main. He succeeded in transmitting melodies which were distinctly heard throughout the room.

If the pitch of a sound were the only quality which we are able to distinguish, the problem of telephony would have received its complete solution in the instrument of Reis. But the human ear is so constructed, and we ourselves are so trained by continual practice, that we recognise distinctions in sound of a far more subtle character than that of pitch; and these finer distinctions have become so much more important for the purposes of human

intercourse than the musical distinction of pitch, that many persons can detect the slightest variation in the pronunciation of a word who are comparatively indifferent to the variations of a melody.

Now, the telephone of Professor Graham Bell is an articulating telephone, which can transmit not only melodies sung to it, but ordinary speech, and that so faithfully that we can often recognise the speaker by his voice as heard through the telephone. How is this effected? If the electrical part of the process consisted merely of alternations between current and no current, the receiving instrument could never elicit from it the semblance of articulate speech.

What we want is not a sudden starting and stopping of the current, but a continuous rise and fall of the current, corresponding in every gradation and inflexion to the motion of the air, agitated by the voice of the speaker.

The electric principle involved in Bell's telephone is that of the induction of electric currents discovered by Faraday in 1831.

Consider first a conducting circuit, that is to say, a wire which after any number of convolutions returns into itself. Round such a circuit an electric current may flow, and will flow if there is an electromotive force to drive it.

Consider next a line of magnetic force. This line, as Faraday first showed, is a line returning into itself, or, as the mathematicians would say, it is a closed curve.

Now, if there are two closed curves in space, they must either embrace one another so as to be linked together, or they must not embrace each other.

If the line of force as well as the circuit were made of wire, and if it embraced the copper circuit, it would be impossible to unlink them without cutting one or other of the wires.

Now, if the copper circuit, or the lines of force, move relatively to each other, then, in general, some of the lines of force, which originally embraced the circuit, will cease to embrace it, or else some of those which did not embrace it will become linked with it.

For every line of force which ceases to embrace the circuit there is a certain amount of positive electro-motive force, which, if unopposed, will generate a current in the positive direction, and for every new line which embraces the circuit there is a negative electro-motive. force, causing a negative current.

In Bell's telephone the circuit forms a coil round a small core of soft iron fastened to the end of a steel magnet. Now, lines of magnetic force pass more freely through iron than through any other substance. They will go out of their way in order to pass through iron instead of air. Hence a large proportion of the lines of force belonging to the magnet pass through the iron core and, therefore, through the coil, even though there is no iron beyond the core, so that they have to complete their circuit through air.

But if another piece of soft iron is placed near the end of the core, it will afford greater facilities for lines which have passed through the core to complete their circuit; and so the lines belonging to the magnet will crowd still closer together, to take advantage of an easy passage through the core and the iron beyond it. If, then, the iron is moved nearer to the core, there will be an increase in the number of such lines, and, therefore, a negative current in the circuit. If it is moved away there will be a diminution in the number of lines, and a positive current in the circuit. This principle was employed by Page in the construction of one of the earliest magneto-electric machines, but it was reserved for Professor Bell to discover that the vibrations of a tinned iron plate, set in motion by the voice, would produce such currents in the circuit as to set in motion a similar tin plate at the other end of the line.

(To be continued.)

Review.

Exposé des Applications de l'électricité. Par Le COMTE DU MONCEL, &c., &c. Tome V. Applications Industrielles. Paris: Eugène Lacroix, 54, Rue des Saints-Peres.

IN the work before us the indefatigable Comte du Moncel brings his arduous undertaking to a close. The five volumes with which he has enriched scientific literature have dealt in the most thorough and masterly style with the manifold practical applications of electricity. This fifth volume bears more especially upon such practical applications as are of use in manufactures, and is brought down to the most recent times, so that an account of Bell's articulating telephone, and other forms of telephones, and also of Jablochkoff's recent invention of the kaolin candle for electric lighting are included.

Some idea of the comprehensive nature of the contents of the present volume may be gathered from the following summary:—The applications of electricity for increasing the safety of railways by means of telegraphic indicators, the block system, and the application of electricity for lighting purposes, with a very full account of all that has been as yet theoretically or actually accomplished in this direction; the uses of electricity in civil and military mining, the explosion of torpedoes, its employment as a means of protection against the destructive effects of thunder-storms, its use in electric toys, electro-motive engines, &c., &c. The chief section of the work, however, is devoted to the mechanical application of electricity to various industries, arts, and domestic economy, such as in weaving, musical instruments, fire and other alarm signals, and so forth.

To have carried to a successful issue so vast an undertaking as this would tax the entire energies of an ordinary man. But the author seems to possess an unwearied power of work, for he tells us that in addition he has made thousands of experiments, verified all his electro-magnetic formulæ by actual trial, and published the results of his researches in at least half a dozen lengthy memoirs. M. du Moncel, we suspect, must have some secret application of electricity to the production of brain work, and we implore him to confide to us this great secret.

One fault some may find, but it is an almost unavoidable one when one man undertakes so herculean a labour, namely, that the inventions of the author's countrymen occupy perhaps too con-

spicuous a portion of the work. Our own columns are laid under frequent contribution by the Comte, to whom we would take this opportunity of expressing our thanks for the handsome manner in which he invariably acknowledges the sources of his information and his generous appreciation of the *Telegraphic Journal.* Excellent plates and numerous woodcuts illustrate the preceding volumes as well as this Part V., which extends to 353 pages, and is nevertheless sold at 12 fr. 50 c. When will English booksellers learn the lesson the French are so continually teaching us, of giving us the book and leave the binding to take care of itself as taste or means may dictate.

Heartily do we congratulate the distinguished author on the completion of his laborious task, which he tells us "Has cost more labour than anticipated, as the help on which we depended completely failed us. We believe," the Comte adds, "that we have carried our work to the limit of present scientific progress, and if some recent telegraphic inventions have rendered the third volume, which deals exclusively with this subject, somewhat incomplete, we hope to remedy this defect in a work to be published at some future day."

It goes, without saying, that the study of these five volumes will give any reader a complete idea of the numerous practical applications of electrical science. Their scope is, however, wider than this, as we have pointed out in previous notices of the earlier parts, for the sources of electricity are fully dealt with, and when needful, theoretical as well as practical points are amply discussed. The scientific public owe Comte du Moncel a large debt of gratitude for the compilation of these volumes, which will always be a mine of information to the engineer and a monument of industry in memory of the author.

W. F. B.

Notes.

THE TELEPHONE.—The first telephonic accident is reported from Hartford, Connecticut, United States. A medical man of that town was recently conversing by telephone with his assistant at the drug store, when a thunderclap burst over head. The doctor observed the telephone in his hands blaze with light at the moment of the lightning flash, and found the coil inside to be fused. The assistant who at the moment held his telephone to his ear in the act of listening, was struck deaf by a loud report like the explosion of a pistol, and continued deaf for several hours.

M. GRENIER, at the French Academy recently, pointed out that besides the induction clamour on air telephone lines, there are irregular noises often very loud, which are best heard in the stillness of night, and he attributes them to terrestrial currents in the wires. M. Du Moncel attributed these currents to the differences of temperature in the wires caused by solar heating, as the sunlight travels over the earth's surface.

RECENT experiments by M. Navez, a French lieutenant of artillery, appear to negative the deduction of Count du Moncel, that it is the core of a Bell telephone which gives out the sounds. Five telephones were tried by him without discs, and although the sending telephone was one of Edison's, giving loud articulation when the discs were present, they were entirely mute without the latter. M. Navez concludes that the core does not produce sonorous vibrations by itself; but undergoes magnetic variations which cause the plate or disc to vibrate so as to give out sound. This brings us back to the original explanation of the action of the telephone, and it is probable that the curious results of Mr. Spottiswoode and others may have been due to conditions in which mere molecular vibration played an important part. M. Navez also obtained speech by means of plates of copper, glass, wood, cardboard, vulcanised india-rubber, gutta-percha, and paper, the non-metallic substances being coated with copper foil. The intensity of the sound varied with the material of the plate, but the pitch and quality were sensibly the same for all.

IN order to eliminate the metallic twang of certain telephones, M. Maiche forms the plate of a sheet of caoutchouc 4 centimetres in diameter and 1 millimetre thick, stretched in front of the pole of the magnet. At the centre of this sheet and opposite the pole in question, he fixes a disc of white iron 1 millimetre thick and 3 centimetres in diameter. M. Maiche has also remarked that the plate of the sending telephone may be 8 or 10 centimetres in diameter; but that of the receiver gives a maximum effect when between 30 and 40 millimetres in diameter.

PROFESSOR SAMUEL E. RUSK (America) has observed that ordinary telegraph instruments give out the tunes and sometimes the words spoken into the line through a telephone.

PROFESSOR RUSK has also devised a telephone call within the instrument itself. By pressing a knob, the sound of the voice is given out at the receiving telephone sufficiently loud to draw attention. On relieving the knob, speaking can be carried on in the usual way. We suppose the knob throws a battery in circuit and the vibrations of the diaphragm then interrupt the circuit; a plan which we believe M. Breguet is also working out.

THE MICROPHONE—ITS INVENTOR.—The Duke of Argyle in speaking at the special meeting of the Society of Telegraph Engineers on the occasion of the reading of Professor Hughes' paper on the Microphone, said that he was glad that that invention had been made by one who, although long a resident in this country, was by birth a citizen of the United States. The Duke then went on to say that although no one was more patriotic than he, yet he was thoroughly cosmopolitan

in matters of science, and, moreover, he could never forget the fact that the Americans were our own fellow countrymen. Most Englishmen will cordially agree with the last remark; for although some Americans will stubbornly entertain the idea that Englishmen are prejudiced against them through jealousy, it is a mistake on their part. They are somewhat thin-skinned as a race, and attach too much importance to the half-jesting criticism of Englishmen. We are proud of the recent great inventions of America, and give her full credit for them. It would have been well, however, had the Duke of Argyle verified his information on the subject of Professor Hughes' birth before alluding to it in such terms. Professor Hughes is not an American. His parents were Welsh, and he himself was born in London. He went to America with his parents when very young; and may be said to have received his education in America. He early developed a strong liking and fitness for the physical sciences, and was appointed Professor of Physics, in Columbia College, Louisville, Kentucky, at the age of 19. His first great work the Hughes' Type-Printer, was done in America, and should be regarded as an American invention. The Microphone, however, is, on the other hand, a peculiarly English invention. Professor Hughes has for many years resided in London, the city of his birth, and it was last winter while confined to his chamber by an attack of bronchitis, the result of our sterling English climate, that to amuse himself he directed his mind to the telephone, and to the problem of discovering a means of making the wire or some part of the circuit itself speak. The experiments of Sir William Thomson on the modification of the resistance of wires under stress gave him the clue which he has followed up with such remarkable success. It is curious to learn that the term Microphone was apparently first used and applied by Mr. H. G. Bonavia Hunt (Mus. B., Oxon) at a lecture which he gave to the students of Trinity College, London, about nine months ago, on some simple means of magnifying normally inaudible sounds, and so obtaining the natural harmonies of bells, steel bars, and other instruments, musical or otherwise. In fact, twelve months ago, Mr. Hunt employed a rough and ready microphone, for experiments; but not, we understand, of a kind similar to that of Professor Hughes.

THE sale of microphones has been promptly opened by our enterprising instrument makers. Messrs. Lancaster and Sons, Birmingham, offer a very handy kind in which the battery is formed of a zinc and carbon plate, with moistened paper between, the carbon plate being at the same time the base plate of the microphone, which consists of an upright pencil of carbon standing on the base plate and leaning against another horizontal plate of the same material. The resistance of this pile is very small. Mr E. Paterson, Covent Garden, Mr. J. W. E. Archbutt, Westminster Bridge, Messrs. Tisley and Co., Brompton Road, Messrs. Ladd & Co., Beak Street, Regent Street, Mr. Volk, of Brighton, and Messrs. Jackson & Co., Barbican, are all advertising different varieties of microphone.

AT the recent *soirée* of the Institution of Civil Engineers, the famous fly-walking experiment with the microphone was a source of great interest to the guests; and we observed not a few worthy civil engineers to be greatly excited over the peregrinations of a fly which had been stone dead for a considerable time. The poor fly had got crushed under its prison walls—a martyr to science—but the *savants* of the *soirée* heard it walking all the same. It should be added that there was a good deal of talking and moving about in the rooms.

PROFESSOR HUGHES states that the best articulation is obtained from the microphone when the internal resistance of the latter is half the external resistance of the circuit.

MR. F. J. M. PAGE, of the Physiological Laboratory, University College, writes to a contemporary to point out that speaking or singing into a microphone caused large and definite movements of the mercury column of a Lippmann's electrometer connected in circuit with it, but placed 25 feet from the microphone. The microphone circuit was formed of three pieces of gas carbon, a Daniell cell and the primary coil of a Du Bois-Raymond induction coil. The secondary coil was in circuit with the electrometer.

WITH a single bichromate cell the microphone can be employed on a circuit of 10,000 ohms resistance; and with an induction bobbin it may be heard through much higher resistances.

ALL letters are sent by microphone with equal facility except S, which, when final, is lost, but may be divined from the rest of the sentence.

BY the introduction of an induction bobbin in the microphone circuit, the Bell telephone is made to speak so loud as to be heard throughout a large hall.

DR. RICHARDSON is engaged in applying the microphone as a means of auscultating the lungs and heart.

THE microphone is an extremely sensitive thermoscope. The heat of the hand on approaching it, and the sunshine and shadow, cause considerable variations in the current passing through it. In fact, so sensitive is it to heat that it is almost impossible to keep it in the same state.

WITH the aid of Professor Hughes, Sir Henry Thompson has successfully applied the microphone to the operation of lithotrity, or crushing of stone n the bladder. As practised at present, the delicacy of the

surgeon's sense of touch is the only detector of the pieces of stone; but with a microphone attached to the handle of the Sound, or crushing instrument inserted into the bladder, it is possible to detect minute fragments of stone which formerly escaped notice, and consequently to crush them, and render the operation more thorough and complete. On Tuesday, June 4, Sir Henry demonstrated this use of the microphone in the Anatomical Theatre of University College, before a crowded audience of his profession. The microphone must not be too sensitive, and the contact of the Sound with the bladder walls should give a soft noise quite distinct from the sharp metallic ring when it strikes a piece of stone.

THE microphone, when fitted to probes, will doubtless become useful to detect bullets or fragments of bone in wounds. Practice will be necessary to enable the surgeon to tell the nature of the foreign matter, whether it be bone or bullet.

AT the meeting of the Physical Society on Saturday, June 8, Professor Hughes gave an account of the microphone, and added some interesting facts to those already published by him. He finds that a continuous sound may be given out by the telephone in circuit with a microphone by a mutual interaction of the two instruments. For example, let the telephone be placed on a table, then if the microphone in circuit with it be set down on the table also, the jar of placing it will cause the microphone to elicit a sound from the telephone; this sound in the telephone will in its turn again jar the microphone, a second sound will be produced in the telephone, and so on—the sound relaying itself. In this way the microphone can be used to relay or translate the voice over wires. Professor Hughes also broke up the continuous humming into dots and dashes.

BY means of the microphone circuit placed against the head, Professor Hughes has enabled deaf people to hear the tick of a watch and other small sounds; and he has been led to the curious supposition that it is through the bones of the head, and not through our ears, that we hear ourselves speak. In connection with this subject, we may mention that deaf persons, or those stopping up their ears, can be made to hear the speaking of a string telephone by passing the string in a loop round their temples. At the same meeting attention was also called to Edison's Carbon Telephone, which evidently depends for its action, at least to a certain extent, on the principle of the microphone. But it cannot be claimed for Mr. Edison that he in any way anticipated the microphone. He discovered the property which carbon possesses of diminishing its resistance under pressure, and applied it to the telephone. Professor Hughes, by a line of reasoning and experiment not even suggested by Edison's telephone, has arrived at the general principle that the resistance of a large class of bodies is modified by sonorous and other mechanical vibrations. Carbon happens to be a particular case of this generalisation. Professor Hughes employs it in the microphone because it is a good and inexpensive conductor. Mr. Edison, had he gone further, might have discovered the microphone. As it is, his carbon telephone is not a microphone. Professor Hughes showed that so long as the diaphragm was there it could not become one. The ticking of a delicate watch, and other small sounds, cannot be heard in an Edison telephone; take the diaphragm away and they can, for it then becomes a particular form of microphone.

A GENTLEMAN in Halifax, L. J. Crossley, Esq., who takes great interest in electrical matters, had a microphone placed in a chapel on Sunday, June 3rd, and connected with his residence, about a mile away, by means of a telegraph line passing near the chapel. The whole of the service was heard, with the exception of a few words, which were occasionally lost through the preacher shaking the microphone, about the presence of which he knew nothing. During the week, a microphone has been placed in the schoolroom of another chapel, and the singing of the scholars was carried in a number of directions by means of telegraph wires. We understand that the microphone is about to be put to practical use for the conveyance of sermons, &c., the gentleman already named having made arrangements for his house being connected with that of a gentleman near, in order that an invalid lady may have the pleasure of hearing in her own room the service of a church over a mile distant.

MR. CROSSLEY and MR. EMMOTT, of Blakey Bros. and Emmott, have also succeeded in speaking, and in transmitting the trampling of a fly, &c., by microphone, over two telegraph wires, between Bradford and Dean Clough, looped at Bradford, so as to make twenty miles of wire in all.

THE PHONOGRAPH.—The phonograph is being exhibited daily in action at the various establishments of the London Stereoscopic Company, who are sole licensees of Mr. Edison's patent. As the nature of the point of the stylus is found to be important in affecting the articulation, these points are now made of ruby. Any improvements Mr. Edison makes on this, his favourite invention, will be reproduced by Mr. Stroh, the maker in England. The Stereoscopic Company have also issued an interesting shilling pamphlet on the phonograph, including extracts from Mr. W. H. Preece's lecture before the Physical Society, and the reports and interviews of several American journalists with Mr. Edison.

AT the opening of the new Metropolitan Central Fire Brigade Station at Southwark Bridge Road, it was stated that, in 1866, there were only 15½ miles of telegraph line in use by the Fire Brigade in the Metro-

polis, whereas there are now 104 miles. There is now instantaneous telegraphic communication between all the stations, and the arrangements for the protection of property within the City proper, were much more complete and efficient than they ever could be before. We may add that there are now 50 Fire Engine Stations, 4 Floating Stations, 3 Floating Steam Fire Engines, 27 Land Steam Fire Engines, 98 Manual Engines, and 406 men of all ranks. It is to be hoped that the next improvement will be the systematic introduction of Fire Telegraphs.

AT the recent special meeting of the Society of Telegraph Engineers, Dr. C. W. Siemens, in pointing out the probable utility of the telephone, microphone, and phonograph, threw out the suggestion that the gray matter of the brain may be a kind of phonograph foil on which are recorded all the impressions of our senses, and which serves as a store-house of experience. The idea is interesting inasmuch as it gives us a glimpse of an old fact from a new point of view.

IN the new fairy drama of "Elfinella," at the Princess's Theatre, the electric light is employed with very beautiful effect.

TELEGRAPHIC COMMUNICATION WITH THE CAPE OF GOOD HOPE.—In reply to Colonel Mure, Sir M. H. Beach, in the House of Commons, on May 31st, stated that recent events had specially directed the attention of Her Majesty's Government to the want of telegraphic communication between this country and the Cape of Good Hope. Looking to the peculiar circumstances of the case, and the absence of any prospect that within a reasonable time such communication would be established by private enterprise, they would be prepared to give favourable consideration to a proposal that in some form or other the Government should aid in such an undertaking, provided that the several colonies interested also contributed to the work. Shortly after his accession to office, he addressed a despatch to this effect to the governors of the several colonies; and should the replies be favourable, he would lose no time in inviting the attention of his colleagues to the details of the subject, in order that the best plan might be adopted for carrying out a proposal which was of the greatest importance.

A brilliant bluish fire-ball passed over south-west London about 9.30 p.m., June 7th, proceeding in a north westerly direction.

THE Great Northern Company's Hong-Kong-Amoy Cable has been provisionally repaired. Further repairs have been postponed until the Singapore route has been re-established. The repairing operations were commenced on May 27th.

AT a recent meeting of the London Clinical Society, Mr. McHardy gave an interesting account of the extraction of an iron chip from the eye of a smith, by means of a magnet. The chip had entered the crystalline lens within the pupil. An electro-magnet, actuated by two Groves's cells, was directed to the cornea, and when four inches distant, the chip sprang from the lens to the inner surface of the cornea, and fell into the anterior chamber, whence it was removed.

THE Eastern Extension Company notify the repair of their Singapore-Saigon Cable. Messages can now, therefore, be forwarded to China and Japan by that route.

THE short section of the Direct United States Cable between Torbay N.S., and Ryebeach, N.H., has been repaired.

THE Government of Buenos Ayres intend to establish a telegraph line from Zarate to Entre Rios, so that messages may go direct instead of by Rosario.

MR. J. A. EWING, B.SC., F.R.S.E., has been appointed Professor of Mechanical Engineering in the University of Tokio, Japan.

THE Messenger Call system will be commenced in London on and after July 1st, by "The Exchange Telegraph Company," of 17 and 18, Cornhill, that company having already secured a sufficient number of subscribers to warrant every probability of success.

THE freaks of lightning are many and versatile; but we confess we were not quite prepared to hear the announcement made the other day by a reporter of the most learned *Times* that, during a recent thunderstorm at High Ongar, the lightning "ignited a quantity of unslaked lime."

DURING the thunderstorm which passed over Perthshire on June 4th, the obelisk erected near Crieff, in 1832, in memory of Sir David Baird, the hero of the storming of Seringpatum, was almost entirely destroyed by lightning. It was 80 feet in height, and cost £4,000 to erect.

THE Lord Chancellor, in moving the second reading of the Telegraphs Bill in the House of Lords, stated that it was the object of the bill to provide one general Act for the protection of the telegraphic system. It was the wish of various telegraphic companies that a special Act should be passed for that purpose.

TELEGRAPHISTS' PARALYSIS.—As a remedy for this complaint, so prevalent in America, Mr. Barron, a practical operator, has, we learn from the *Journal of the Telegraph*, invented a flexible or elastic knob for the signalling key, which relieves the strain on the hand and fingers caused by grasping a rigid knob in signalling. It is now used by all the operators on the Associated Press wire, and those on the fast Western

Union circuits worked from New York. Operators who have suffered from paralysis are said to find relief in their use.

IT is proposed to erect a monument to the memory of the late Mr. William Orton, president of the Western Union Telegraph Company, U.S.

As a slight specimen of American "hifalutin" oratory—for the abundance of which we cannot help thinking that Mr. Emmerson is greatly to blame—we extract the following from a lecture by the Rev. T. Dewitt Talmage on the late Mr. Orton :—" From the most animated electric life he has gone to lie down in the village cemetery. . . He was the martyr of American telegraphy. . . He had been gathering up the lightnings of the Pacific and Atlantic, the Gold and Stock, Southern and Atlantic, the Atlantic and Pacific Telegraph Companies, and a cable company to Cuba ; and no wonder that in the attempt to harness and drive so many lightnings the hands that grasped the fiery reins were consumed." "Gathering up the lightnings" is surely a very poetical rendering of the establishment of a telegraph monopoly.

ACTION OF LIGHT ON SELENIUM.—Recent experiments of Mr. R. Sabine on this subject (see the *Phil. Mag.* for June) tend to prove that the impingeing light effects a true decrease in the resistance of the selenium; rather than rise of electro-motive force in the same direction as that of the battery.

WE hear that Muirhead's duplex system is about to be applied to the Madras-Penang section of the Eastern Extension Telegraph Company's system.

MR. FULLER, an American, has patented in the United States an electric wick, formed of two carbon sticks placed side by side, at an angle to the vertical, but separated from each other by a slip of glass, which fuses in the current as it passes between the points of the carbons, after the manner of the kaolin in Jablochkoff's electric candle. This lamp is said to cost only 12s., but it is a variety of the electric candle. Jablochkoff does not restrict himself to kaolin, but mentions other refractory substances, and the principle is his discovery. Mr. Fuller is also the inventor of a dynamo-electric machine, and a method of dividing the current so as to supply lamps of different sizes.

DURING one of her recent cruises the French war-ship *Desaix* had in tow an old vessel called the *Argonaute*, which served as a torpedo boat, and telephonic communication was maintained between the two ships during the whole time. An insulated conductor was wound round the tow-rope, and the return circuit was formed by the sea, a circumstance which in the opinion of M. Trève, one of the officers of the *Desaix*, improved the definition of the sounds.

ALLOTROPY OF ELECTRIC RESISTANCE.—At the meeting of the Physical Society on May 25, Sir William Thomson stated that the spiral flow of an electric current traversing a metal tube under torsion may be resolved into two components—one right along the tube, the other round it. The latter would (like the current through a galvanometer coil) deflect a needle hung in the interior of the tube with its axis perpendicular to the tube when undisturbed, or it would magnetise a bar or wire of soft iron placed within the tube. The current itself would (except near the end of the tube) produce no external effect directly; but either of those appliances may be used to give an external indication. Experiments were made for Sir William by Mr. Macfarlane in the physical laboratory of the University of Glasgow on the last-mentioned plan ; and on the former plan by Mr. J. T. Bottomley in the physical laboratory of King's College, London, by kind permission of Prof. Adams, and with the valuable assistance of his staff. Mr. Macfarlane, using a small mirror magnetometer suspended externally in the neighbourhood of one end of an iron wire placed within a brass tube, found that when the twist of the substance was right-handed the end of the wire next that end of the tube by which the current enters becomes a true north pole. Mr. Bottomley, with the cell and suspended mirror and needle of an ordinary dead-beat mirror galvanometer, supported by an independent support within a brass tube along which a current is maintained, found that the true north pole of the needle is moved towards the end of the tube by which the current enters. Thus both Mr. Macfarlane's and Mr. Bottomley's observations confirm the anticipation that the electric conductivity is least in the direction of greatest extension, and greatest in the direction of greatest contraction of the metal. The apparatus by which Mr. Bottomley had made his experiment was exhibited to the meeting. It included a mode of balancing the effect on the internal needle by placing a circular portion of the main circuit at a proper distance from it, the centre and plane of the circle being in and perpendicular to the axis of the tube. From a measurement of the distance from the centre of the circle to the needle, when the balance is obtained, the ratio of the maximum to the minimum conductivity can be calculated. For further information on this subject, see our account of the Physical Society's meetings in last number.

DURING the recent Epsom Races the wires between the Grand Stand and the Post Office were worked by Wheatstone's Automatic instruments duplexed. In one hour 219 messages were sent in one direction, and 139 in the other—358 in all. More could have been sent in the latter case had there been more to send. The messages were of the ordinary kind, and of the average length, and not mere "results." This is believed to be the largest number of messages ever sent on one wire in the same time.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£ a	£	£	£	£ b	£	£	£	£	£	£	£	£
May, 1878 ...	42,990	12,564	3,500	817	11,650	33,650	23,844	19,463	... ...	10,584	... ...	10,652	5,705
May, 1877 ...	45,420	12,378	4,109	972	17,370	46,309	25,445	18,427	... ...	11,048	2,170	10,534	7,507
†Total Inc. 1878	74,200	112	... ...	... ...	... ...	... ...	... ...	4,519	... ...	... ...	... ...	... ...	... ...
†Total Dec., 1878	... ...	... ...	426	400	3,950	11,968	2,861	... ...	... ...	1,519	... ...	2,291	1,555

a Amount accruing by arrangement with Direct Co. b Amount subject to arrangement with Anglo Co. † Compared with same period (five months) 1877.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).

New Patents.

1882. "Improvements in telephones and in apparatus connected therewith."—J. F. BAILEY, (communicated by E. GRAY), May 10. (Complete).

1889. "Lighting ordinary coal gas jets by electricity.—A. R. MOLISON, May 10.

1913. "Cleaning grain of the pieces of iron contained therein by the use of magnets."—G. SCHAEFFER, May 11.

1917. "Improvements in transmitting and receiving electrical and telephonic excitations, and in the construction and use of the apparatus employed therein."—A. S. HICKLEY, May 13. (Complete).

1927. "Construction and application of electric apparatus."—P. JENSEN (communicated by A. J. B. Cance), May 14.

1932. "Improvements in galvanic batteries and electrical apparatus, and in the application thereof for producing novel theatrical effects."—W. SCANTLEBERRY, May 14.

1937. "Coating or covering electric telegraph wires."—W. ABBOTT, May 15.

1988. "Improvements in phonic wheels or in driving and regulating the speed of wheels by electricity."—P. LA COUR, May 17.

2003. "Apparatus for the generation and application of electricity for lighting, plating, and other purposes."—H. J. HADDAN, (communicated by C. Brush), May 18.

2096. "A hydro-electric brake applicable to all rotating and rolling machines, either stationary or moveable, and specially to railway trains."—W. MORGAN-BROWN (communicated by J. Sabatier and L. Pouget), May 25. (Complete).

2137. "Improvements in telegraph signalling apparatus for increasing the speed of working telegraph cables or long highly insulated aerial lines, which I call 'Trimmer's electro-magnetic arrangement.'"—F. TRIMMER, May 29.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

3404. "Door locks." — GERARD WENZESLAUS VON NAWROCKI, Berlin (communicated by Alphons Lemke, Aschaffenburg, Germany). Dated, Sept. 7, 1877. 10d. This consists in constructing new or modifying old locks, so that they can be opened from a distant place by means of electricity or air pressure. The bolt is withdrawn by being connected to one end of a double-armed lever, the other or lower end of the lever being connected to a pulling spiral spring. When the door is shut, this lower end is held down by a projection on the boss of another or detent lever which rests, in the case of an electric lock, against two electro-magnets, and is attracted by them when a current is passed through the coils, so as to liberate the bolt lever and open the lock. When the current stops, a spiral spring raises the detent lever. The keeper of the electro-magnet can be regulated by a set spring. In the pneumatic form of lock, the detent lever is sprung by a double-armed lever, which can be raised by a column of air in an india-rubber pipe. While the bolt lever pulls the latch out of the door post, another bolt is thereby thrown forward. This bolt has a wedge shaped nose, which, coming against a correspondingly formed projection on the post, causes the door to open. This bolt also serves to set the whole mechanism for the next operation when the door is slammed to, a spring on its tail pushing the bolt lever back again.

3469. "Generating and applying electricity."—J. L. PULVERMACHER. Dated, Sept. 14, 1877. 10d. This consists in designs for "galvanic chain bands," &c., in the construction of a portable galvanic apparatus for personal application, and in an automatic compensator galvanometer, which, by means of a set of points or teeth on the needle, inserts or takes out resistance from the circuit by making and breaking contact with mercury cups.

3487. "Electric telegraph apparatus."—L. A. BRASSEUR, and S. W. M. DE SUSSEX, Brussels. Dated Sept. 15, 1877. 4d. This consists in raising the inking armature of a Morse instrument by an electro-magnet, formed of a horse-shoe magnet fitted with soft iron pole pieces, having coils wound round them. This horse-shoe magnet acting through the soft iron cores attracts the armature, and holds it away from the electro-magnet. The coils of this magnet are in circuit with those of the electro-magnet in circuit with the line, in such a way that the line currents, while causing the latter to attract the armature, cause the former to repel it by temporarily reversing the polarity of the soft iron poles. *(Not proceeded with.)*

3549. "Telephones."—T. W. MANN (communicated by J. A. Briggs, Coconada, E.I.). Dated, Sept. 21. 2d. This consists in certain arrangements for a vibratory telephone, such as the employment of a sounding drum at each end of the medium of communication, which may be of galvanized iron wire, or a tube filled with water, &c., in a strained condition. *(Not proceeded with.)*

3552. "Constructing and arranging magneto-electric apparatus."—A. S. HICKLEY, Dated, Sept. 21, 1877. 6d.

This describes an improved means of generating magneto-electricity applicable to signalling and other purposes. To each pole of a permanent magnet, which is mounted horizontally in suitable bearings, insulated when necessary, is attached one end of a small bar of soft iron, the other end having attached thereto a vertical rod of the same metal which acts as a core to a coil of covered wire, through the centre of which it passes, and projects slightly above the top of the same. A bar of soft iron rests upon the tops of the two vertical rods, which are connected with the respective poles of the magnets, and forms an armature. This armature is attached to one end of a lever, the other end being capable of being depressed by means of a rod and stud, or other suitable contrivance; and when so depressed the lever turns on a pivot, and raises the armature off the tops of the vertical rods. To work the apparatus, the armature is raised, and electricity thereby generated in the coils.

3597. "Electric Telegraphs."—F. H. W. HIGGINS. Dated, Sept. 25th. 2d. This is designed to produce audible signals through submarine cables by causing a disc of iron, under the influence of a magnet, to give out a ticking sound on any alteration of the strength of a current flowing round the magnet. The latter would be an electro-magnet, and the line current, by the intervention of a condenser or an induction coil, would be made to intensify the ordinary power of the magnetism, thereby causing the disc to sound. Two discs might be employed to yield different notes in correspondence with the Morse alphabet.

3639. "Electric Telegraph Apparatus."—L. A. BRASSEUR and S. W. M. DE SUSSEX. Dated, Sept. 29th. 8d. This includes the improved Morse armature described above in patent No. 3487, and also describes a sensitive relay, consisting of two double-bobbined electro-magnets, placed pole to pole. Between the poles of these two opposed electro-magnets, a long soft iron lever or tongue is supported by two silk fibres from the same point of an upright rod or post. One end of this tongue abuts against the foot of this post and turns round it as round a pivot; the two fibres otherwise support the tongue between the poles. The other end of the tongue travels between contact points when the true current operates. To further increase the sensibility of the tongue the whole is enclosed in a copper box from which the air is exhausted.

Correspondence.

[We do not hold ourselves responsible for any opinions expressed by our correspondents.—ED. TEL. JOUR.]

THE WEST INDIA AND PANAMA TELEGRAPH COMPANY'S SERVICE. *

SIR,—An article appeared in your *Journal* in August, 1877, vol. 5, No. 108, and one also in *Cassell's Family Magazine* for January, 1878, entitled, "The Submarine Telegraph Service."

No one who has been in the Submarine Telegraph Service can do otherwise than support the statements of the writers of those two articles; and I now purpose to treat the same subject, particularly bearing on the West India and Panama Telegraph Company's Service. . . . .

The first drawback to a clerk is that there is no scale of promotion in the service, all salaries being individual and not attached to office; this system damps any ardour or ambition, and throws the clerk into an apathy that is as detrimental to the company as it is to himself. It is as well that a proper explanation on this point should be clearly given. When the clerk-in-charge of a station, whose salary we will say is £320, resigns, or is dismissed, his second in office is raised to the clerk-in-chargeship, on a probation, which probation, unfortunately, may run over a couple of years, during which time his endeavour to prove himself worthy of the £320, has at the expiration of that time, to be disappointed with some flattering reply, to his application for increase of pay, by being told that the matter has been referred to the Board of Directors, which practically means that *it has been thrown into some pigeon-hole or waste-paper basket* never to be remembered, till the poor applicant is some months after compelled again to draw attention thereto, when he *may* get a trifling increase on his pay as a subordinate, notwithstanding the important fact that he is in charge of the office, and subject to all its responsibilities and impositions; and if it be possible for the superintendent to trump up any trivial shortcomings of his, to evade giving him such increase, he is frequently, on the face of his having endeavoured to do his best towards promoting the company's interest, compelled to leave the service as the company seem to have no appreciation of his services. The shortcomings of the clerks are visited by fines, and not unfrequently with reductions of pay or deprivation of promised increment.

It does not matter what interest a clerk may take in the service, his suggestions are simply carried out if practicable, and he only receives in recognition a flattering but evasive letter, and a promise which is as quickly forgotten, as it was written; a reminder of the same *may* be visited with the greatest indignation. His services are not taken into consideration, and carefully weighed against his shortcomings.

The appointment to a clerk-in-chargeship is made irrespective of length of service, intelligence, and practical and theoretical knowledge of the work; and this is scarcely to be wondered at when the General Superintendent goes through the stations, say but once in four years; he can thus have no practical knowledge of persons, and can only depend on the reports of a clerk-in-charge. These are not unfrequently partial, being at times unjustly injurious, or unduly flattering, to the party to whom it may refer, and if the party reporting has previously predisposed the General Superintendent favourably to himself, his influence may be prejudicial to the interest of subordinates. There are instances when the General Superintendent's opinion of the staff at stations is only formed from the correspondence of the clerk-in-charge about them, and those communications are far from being free from *prejudice*, *self-esteem* and *avarice*. In many instances personal advancement has worked rather an evil influence on the destinies of underlings.

The salaries of the clerks, already inadequate, both as regards their responsibilities and the expensiveness of the colony, are nevertheless subject to deductions for fines.

If the Telegraph Company desire to ensure the services of respectable, honest, and efficient servants, these must be properly paid. A clerk-in-charge in the most expensive colonies should be in receipt of £350, the second in office, £250, and so on down to £180, with annual increments of £10 and £5. The clerk-in-charge of a less expensive colony, where there may be less work, should get £200 per annum, with increment of £10, and his junior, £150, with £5 increment. This would command good and intelligent operators, and respectable men. By such a fixed scale of salaries, clerks will be ambitious in working up from £150 to even £250. It would also obviate the necessity of paying gentlemen in Trinidad, Demerara, and the Spanish and French islands as bankers or agents, as the salary could procure a gentleman to fill those important stations without the risk of embezzlements; and even as regards that, they might be made to give sufficient security to cover the probable receipts passing through their hands per month. The company needs no represen-

* We publish only those portions of this letter which have not a personal bearing.—ED.

tatives to the governments beyond the clerk-in-charge, as it can, with the Secretary of State for the Colonies in London, use all the influence required for its benefit. . . . .

By having *gentlemen* at a salary to ensure efficiency and command respect, the entire administration would be more satisfactory, and the position as clerk-in-charge of a station would be looked upon by the public as important and trustworthy; it would invite confidence and ensure respectability.

It would not be amiss to throw out some suggestions with respect to the improvement necessary.

1st. The department of the General Superintendent to be lessened in cost.

The salary of the General Manager of Telegraphs in New Zealand, is only £650 and his accountants £350, yet this little company can afford to let their General Superintendent's department cost them over £2,300 per annum, to manage a couple of dozen petty stations, yielding a net revenue, exclusive of subsidies, of about £12,000 per annum, on a capital of £883,210.

2nd. There should be no assistant superintendent. . . . .

3rd. The agencies should be abolished, and respectable and efficient men, backed by proper security, employed as clerks-in-charge.

4th. The stations should all open at 6 a.m. and close at 6 p.m. on week days, and 7 a.m. to 10 a.m. on Sundays.

This would enable the staff to be reduced, and the remaining staff be made efficient, and *well paid*. There is not sufficient traffic to necessitate opening at nights, especially as the delivery of messages is unnecessary after 5 p.m., as the business places close at that hour.

The present staff is four or five at each large or transmitting station, and two at intermediate ones, inclusive of the clerks-in-charge. This could be reduced to three at the large or transmitting stations, and a couple of reserve clerks at St. Thomas for relief purposes.

5th. Each clerk should have at the expiration of three years' service, three months leave of absence on half pay. The clerk acting to receive the one-fourth, and the juniors the other fourth of the pay. In case of sickness, after three months on sick leave, clerk should resign on a gratuity of half his pay, for three months in full, provided he has served three years. Each clerk-in-charge should, after ten years' service, be entitled to a pension of one-third of his pay, and each junior one-fourth.

6th. That learners be accepted, giving a salary of thirty dollars per month for one year, and £150 after, provided competent. Each candidate to give satisfactory proof of having had a liberal education.

7th. That all the rules and regulations of the company should be dispensed with prudence and impartiality.

8th. The General Superintendent should make half-yearly visits through the stations.

9th. That the offices and fittings be improved, and the apparatus be of the best type.

10th. That all reports be searchingly investigated, and be dealt with impartially.

11th. No increments justly earned should be withheld.

12th. That the writing work of the offices be considerably reduced, or mechanical means afforded to make copies of the original records.

13th. For the increase of traffic and convenience of the public, that a *telegraph money order system* be established throughout the colonies, and between the colonies and Great Britain, charging one per cent., or any other reasonable rate of commission, besides the charge of ten words to wire the advice. To Great Britain the amount remitted should not be less than £100, and more than £1,000, and by this the company could realise a splendid revenue, as they could, through the General Superintendent, wire the advice to the Secretary in London in a code, and would thereby economise on the ten words charged for.

In order to avoid statements of a personal nature, it has been difficult to properly convey as full an idea of the present working of the company's business as might be desired. It is, however, hoped that this letter will be found practically useful, and that telegraph companies in general, and the West India and Panama Telegraph Company in particular, will understand that their object should not confine itself only to the dividends they can declare; but also to set a proper value on the services of their *employés*, so that they may be induced to consider the company's success as identical with theirs. To regard such services as mere mechanical drudgery has a most suicidal tendency: it results in the performance of the duties mechanically and without prospect, and renders the *employés* susceptible to every chance that offers for a change of employment. . . .

All reforms suggested herein can be effected without any increase of expenditure, and I can only forsee that from the revolution, profit and pleasure to all concerned, will be the inevitable result.

I am, Sir, yours, &c.

WEST INDIAN TELEGRAPHIST.

Proceedings of Societies.

PHYSICAL SOCIETY—8TH JUNE, 1878.

Professor W. G. ADAMS, President, in the Chair.

The following candidate was elected a Member of the Society, Mr. R. H. Solly.

The SECRETARY read a paper by Prof. Hughes on the "Physical Action of the Microphone." That instrument renders it possible to introduce into an electrical circuit an electrical resistance which varies in exact accord with sonorous vibrations, so as to produce an undulatory current of electricity from a constant source, whose wave length, height, and form is an exact representation of the sonorous waves. Professor Hughes has found that when an electrically conducting matter in the form of powder, filings, or superposed surfaces, is put under a certain slight pressure, far less than that which would produce cohesion, and more than would allow it to be separated by sonorous vibrations, a remarkable state of things occurs, the electrical resistance being caused to vary by rearrangements as regards the form, number in contact, or pressure of the molecules. It is essential that the instrument be so arranged as regards pressure between the touching surfaces as to be adapted to the particular vibrations employed: thus a box suitable for a man's voice is not adapted to observe the tramp of a fly. But in all cases a perfect undulatory current can be secured throughout a certain range; and, when speaking to the instrument, a galvanometer should be interposed in the circuit, and the pressure between the surfaces gradually increased from a minimum until the needle remains stationary, when a maximum of loudness will be attained; beyond this point the sounds die out gradually until there is complete silence.

Professor HUGHES then proceeded to consider the probable cause of the observed phenomena, taking as an illustration the very simplest form of instrument, two blocks held together by an insulated adjusting screw, the lower block being fixed to the board, by means of which it receives the sonorous vibrations. From numerous experiments he inclines to the belief that the whole block increases and diminishes in size at all points, both in the centre and at the sides, in accordance with the form of the sonorous wave, and that this increase in size varies the resistance by changing (1), the pressure at the surface of discontinuity, and (2) the extent of the molecular surfaces in contact. Of these changes he considers the latter has the greatest effect, since some of his best results have been obtained by using two surfaces of solid gold, and not

by such an elastic conductor as metallized silk, which would be most affected by the first-named change. As evidencing the great mechanical effect produced by this uprising of the molecules, he mentioned that, when a large musical box was playing, one ounce of lead did not suffice to maintain two surfaces of 1 sq. c. m. in contact until the box was placed several feet distant. Professor Hughes is now mainly anxious to find some efficient insulator for sounds, as, until such is available, it will be impossible to isolate and study many objects which require investigation from this new point of view.

Professor HUGHES himself then exhibited some of the remarkably simple appliances he has used in his investigations. A very small clock, placed on a small drawing-board which carried a microphone, was used to interrupt a current passing through a telephone, and the tick was immediately audible through the whole room. A very remarkable effect was then shown. The microphone attached to this board being still connected with the telephone, which, being provided with a bell-mouth, enabled the audience to hear the sounds produced, a second telephone was introduced into the circuit, and laid on the board, when a continuous sound was at once produced; this, Professor Hughes explained, would last as long as the battery continued in action, and its explanation is as follows: The act of placing the telephone on the board set up a vibration in the microphone; this passing to the bell-mouthed telephone was returned to the board, and set the second telephone in action, and again passed through its action to the microphone. Hence the action is self-supporting, and it solves in a most perfect manner the question of a relay for the human voice in telephony; for it becomes only necessary to provide such an arrangement at each station for a speech to be both received and transmitted to any number of succeeding stations. The system is perfectly duplex, for if two correspondents speak into microphones and use telephones for receiving, each can hear the other, but his own speech is inaudible, and if each sing a different note, no chord is heard. Experimenting on deaf persons, he finds that they can be made to hear the tick of a watch, but not human speech, and his results have led him to conclude that we only hear ourselves speak through our bones, and not through our ears. Finally, Prof. Hughes illustrated Sir Henry Thompson's method of probing for shots, splinters, &c., by finding a very small shot in the midst of a piece of wash leather.

SIR JOHN CONROY, Bart., M.A., read a paper on the "Light Reflected by Potassium Permanganate." After referring to the results obtained by Haidinger and Stokes, and more recently by Wiedemann, he proceeded to describe his own experiments which have been made by means of a very complete Babinet's Goniometer, provided with a vertical as well as a horizontal stage, so that the reflecting surface could be placed directly over the axis of the instrument. Sunlight unpolarized or polarized in any plane by a Nicol, was used, and the moving arm of the instrument carried a direct vision spectroscope with a "bright spot" micrometer and a reflecting prism for bringing a second spectrum into the field. The colour of a surface, obtained by rubbing the crushed permanganate into a surface of ground glass with an agate burnisher, was found to vary with the nature of the light and its angle of incidence, and it further varied as the surface was immersed in benzone bisulphide, or tetachloride of carbon. With light polarized perpendicular to the plane of incidence the dark bands of the reflected spectrum are far more distinct than when unpolarized or polarized perpendicularly to that plane. In the first of these three cases four bands are observed at angles less than 40°, and the blue end of the spectrum is very weak; as the angle of incidence increases the intensity of the blue rays diminishes. The dark bands gradually shift towards the blue end of the spectrum, and at about 60° a new band appears near D. With a still greater angle more of the blue rays are reflected, and the bands fade away, those in the more refrangible part disappearing first. This displacement amounts approximately to 0·006 tenth metre.

Professor S. P. THOMPSON exhibited and described a cheap and efficient form of optical bench. Two straight oak bars about two metres in length, are clamped together as in a lathe-bed, and a number of slides carrying various appliances slide easily without shake, and can be fixed in any position by wedges. The several frames carrying the diffraction grating or edges, the eye-piece (with an engraved glass micrometer) &c., are so made, in wood, as to be capable of adjustment in any plane, and the instrument can also be employed for making photometric measurements. The mean of two determinations for the wave length of certain red light gave 0·000629 as compared with Fresner's figure, 0·000640, while the total cost did not exceed £3.

The SECRETARY then read a paper by Prof. Ayrton, of the Imperial College of Tokio, Japan, on the "Electrical Properties of Beeswax and Lead Chloride." The index of refraction of the former substance increases in passing from the liquid to the solid state, and it therefore seems important, in connection with the electro-magnetic theory of light, to carefully measure the specific inductive capacity of a condenser made of wax, as it is cooled through its solidifying point. The rise in capacity, as the temperature falls from 80° C. to 60° C., is very striking, and the entire change was found to be in exact agreement with the changes known to occur in the index of refraction for light. An elaborate series of experiments was made which sufficed to show that the results obtained were not due to any change in the distance apart of the plates (of copper) between which the wax was placed, caused by any shrinkage of this wax on solidifying. In consequence of a remark of M. Buff that lead chloride behaves as a metal, Prof. Ayrton has studied it as a dielectric, and he found in every case a diminution of resistance by electrification; but as this result was not confirmed on subsequent experiment, the question was more fully investigated, when he found that with an electro-motive force under 1·75 volts, there is an increase in resistance, and above that amount there is a regular or irregular diminution. This limiting force is about that required to decompose water, and he concludes that the results obtained must be due to the damp contained in the lead chloride.

General Science Columns.

CONTINUOUS BRAKES.

PART II.

IN the recent report of the Royal Commissioners on Railway Accidents the following extract from a report by Captain Tyler, in 1874, is quoted :—"When a form of continuous brake can be decided upon, cheap in construction, simple in action, easily adjusted, not requiring frequent repair, not liable to get out of order, applied at the will of the engine-driver, and available in each part in the event of a train becoming suddenly divided, and with those numerous other properties that a good brake ought to possess, then a further great step will have been made towards safety and efficiency in railway working. But it must be admitted that there are many considerations involved, and many difficulties to be encountered; and it will be far better in the end that time should be afforded for fully discussing, testing, and improving to the utmost, the many systems of

brake-power advocated, than by any premature and general adoption of what may afterwards be found to be an inferior system, to create more or less a bar to urther improvement." These words which have been, to a certain extent, adopted by the Commission by including them in their report, clearly point to the general application of one class or description of brake by all the several railway companies of the United Kingdom. This is, indeed, a most important point, and will eventually be found to be so, wherever intercommunication takes place between different lines, and the carriages of one line are liable to be attached to trains belonging to other companies. This is now a very general practice, and there are few railways whose carriages do not constantly travel on other lines. It is clear, therefore, that unless one uniform system of brake be adopted for all lines, trains, when made up with carriages belonging to different companies, will be liable to have half their length fitted with one system, and the other half with another system of continuous brake, which cannot be worked together, and, in all probability, in this case the brakes on one portion would be wholly inoperative whilst so employed; and, at any rate, the power of automatic action throughout the train would be impossible under these circumstances. However, with a view to the selection of the best form of brake, a great number of different systems have, for some time past, been in operation—chiefly experimentally—on the several lines of railway. The Chairman of the Railway Companies' Association, writing to the Board of Trade in April, 1877, observed that, "As at present advised, it does not appear to the companies essential that one form of brake should be universally adopted, but with the view to secure a general interchange of practical knowledge on the subject, the experience gained by the companies is freely communicated to each other from time to time." In reply it was stated, "If by this it is meant that it is desirable to try every form of brake, and that it is not desirable by the exclusive adoption of one form to prevent the trial and introduction of better forms, the Board of Trade would entirely concur; but if it is meant that there would be no advantage in having one form of brake for all lines which interchange traffic with one another, the Board of Trade hold a different opinion; for it appears to them obvious that in the interchange of rolling stock, including ordinary carriages, saloon and family carriages, horse-boxes, carriage and fish trucks, and other vehicles forming part of passenger trains, between one line and another, if the brake fittings are not similar, the efficiency of the brakes must be proportionately impaired, and that this must be especially the case where the lines of two or more companies are continuous." The London and North Western, the Great Northern, and the Midland Companies all run through trains to Scotland, which are forwarded over the Caledonian, North-Eastern, North British, Glasgow and South-Western, and Highland Railways. It is, therefore, obvious that the advantage to be derived from any continuous brake system in use on any of these lines will be diminished and neutralized if at such stations as Carlisle, Glasgow, York, Edinburgh, Perth, and Inverness, the traffic is so arranged that carriages fitted with one system of brakes are attached to trains containing carriages fitted with a different system. This evil can only be avoided if those companies, which interchange traffic with one another, adopt one and the same general system. Before describing the different kinds of brake in detail, we extract from the published correspondence with the Board of Trade, particulars as to which brakes have been or are being tried by the several railway companies, and the opinions expressed by them so far as they have been formed from past experience of their working:—

Caledonian Railway.—Westinghouse Atmospheric; Westinghouse Automatic; Clark and Webb's; Steel and McInnes.

Glasgow and South Western.—Westinghouse Atmospheric and Smith's Vacuum Brakes.

Great Eastern.—Westinghouse Automatic; Smith's Vacuum; Barker's Hydraulic; Fay's; and Clark's Chain Brake.

Great Northern.—Westinghouse Automatic; Smith's Vacuum; and Clark's Chain Brake.

Great Western.—Smith's Vacuum; Sanders' Vacuum.

London, Brighton, and South Coast.—Westinghouse Automatic Brake.

London, Chatham and Dover.—Westinghouse Automatic Brake.

London and North Western.—Clark and Webb's Brake.

Midland. — Westinghouse Automatic; Smith's Vacuum; Sanders' Vacuum; Barker's Hydraulic, and Fay's Brake.

North British. — Westinghouse Automatic; and Smith's Vacuum Brake.

North Eastern.—Westinghouse Automatic Brake.

North London.—Clark's Chain Brake.

South Eastern.—Smith's Vacuum Brake.

It appears that the Westinghouse Automatic Brake is used on eight lines of railway; Smith's Vacuum on seven; Clark's Chain on three; Westinghouse Atmospheric, Clark and Webb's, Sanders' Vacuum, and Barker's Hydraulic, each upon two lines; and the Steel and McInnes, and Fay's Brakes each upon one line of railway. In order the better to enable some opinion to be formed of the relative merits of the principal brakes in use, a short description of each of them and of their several performances is appended.

(To be continued.)

THE great statue of "Liberty illuminating the world," which is destined to be placed as a lighthouse in New York Harbour, and is a present from the French Republic to America, is now finished, and will speedily be placed for a time at the entrance to the Paris Exhibition. The idea of this important work was

conceived in 1876, the year of the Centennial of American Independence, by several French admirers of America, and the expense has been shared equally by both countries. It will be erected on Bedloe Island, in the centre of New York Bay, in front of Long Island, where the first blood of the colonists was shed in the cause of liberty. The artist is M. Bertholdi. The figure represents Liberty holding aloft a flaming torch in the right hand, and grasping in her left the tablets on which are inscribed the Declaration of Independence. A diadem encircles her head, and by night it will become luminous, the spokes radiating electric beams which will light up the entire bay, and the buildings of Brooklyn, New York, and Jersey city. In height, the colossal statue is over one hundred feet, and will stand on a stone pedestal 82 feet high. It is made of copper plates fastened round a framework of iron. Instead of filling up the interior with masonry, to give stability to the statue, M. Bertholdi has lined it with compartments, which will be filled with sand. When masonry is employed, an accident often requires the demolition of the whole; but by this device the statue may be repaired by simply tapping the sand.

HEAT OF FLAME.—By means of a thermo-electric apparatus, M. Rosetti, of Venice, has made a determination of the temperature of the flame of a Bunsen burner. His results are as follows:—Exterior flame 1350° C., diminishing to 1200° C. at the dark central cone; interior of cone, top, 650° C.; interior of cone, bottom, 250° C.

WHITWORTH'S "IMPREGNABLE" IRON PLATING.—This formidable armour has been recently tried at Manchester. It is formed of Whitworth's fluid compressed steel, built up in hexagonal sections, which are composed of a series of concentric rings round a central disc; and is designed to guard against the cracking tendency of steel, by confining each crack to the ring it appears in. A Palliser shell weighing 250 lbs. was fired from a 9-inch gun, with 50 lbs. of pebble powder, at a range of only 30 yards from the target, which was 9-inches thick, and set against a backing of sand. This projectile would have passed through 12 inches of ordinary iron armour-plating, but burst harmlessly into innumerable fragments on striking the target, which, however, was driven 18-inches backward into the sand.

A French *savant*, M. Mouchot, has been making experiments in Algeria on the industrial application of solar heat. He collects the sun's heat by reflectors, preferably of brass, electro-plated with silver. The quantity of heat collected per minute by a reflector one square metre in area, is, at Algiers in May and June, about 8 calories. This quantity would boil in less than twelve minutes a litre of water at 20° C., and give 1322 litres of steam at the normal pressure of the atmosphere every hour. Small solar apparatuses for cooking, distilling, &c., have been introduced there successfully by M. Mouchot

HOLMES' INEXTINGUISHABLE SIGNAL LIGHTS.—These lights, which may be of great service at sea, are made by enclosing phosphuret of calcium in an air tight vessel under pressure, and, by means of an automatic arrangement, the duration and intervals of the signal flashes are controlled at will. The entry of the water to ignite the composition and produce the signal flame, is automatically regulated, as also is the escape of the phosphuretted hydrogen gas which results from the combustion. This apparatus has been recently patented by Mr. Holmes.

AGRICULTURAL LOCOMOTIVES.—In a paper read last February by Mr. Aveling, before the London Farmers' Club, and recently circulated, it is stated that the agricultural locomotives at present employed in this country represent in the aggregate 30,000 horse-power, and, with the machinery they drive, may be valued at £2,000,000. The object of the paper is to bring into notice the disabilities under which these locomotives labour, with a view to obtaining the sanction of the legislature to their removal. Mr. Aveling thinks that, in the country, the regulations concerning the consumption by the locomotives of their own smoke should be relaxed; that the man carrying a red flag in front of the engine should be dispensed with; that weak road bridges should be strengthened sufficiently to admit of the safe passage of locomotives, and that the hours during which they may travel should be unrestricted, except in large towns.

We think that due warning should continue to be given of the approach of road locomotives in country districts, as they cannot be avoided, like railways can, by persons driving young or timid horses; and, till these locomotives come into much more general use, it would be unfair to make the cost of strengthening the bridges fall upon the highway rates, especially as the roads suffer considerably from the passage of these engines, and the cost of repairs is hereby materi ally increased.

No fewer than six vessels—two Russian, one German a Swedish, a Dutch, and a Danish—left Europe last month for the Yenisei River by way of the Siberian Sea. The capabilities of this route for summer trade will be tested by them.

A NEW OZONE MACHINE.—Professor Leeds exhibited recently at the Stevens Institute, New York, a new machine for producing ozone in large quantities. Pure oxygen is cooled to zero temperature, then thoroughly freed from moisture, and afterwards passed through highly electrified tubes. The ozone thus produced displays intense chemical power, oxidising silver and bleaching indigo instantly.

THE first part of the new edition of Thomson and Tart's *Natural Philosophy*, so long looked for, will shortly be issued by the Clarendon Press.

THE Commissioners of Patents have determined to revise and reduce in size the series of indexes of the subject matter of English patents. A competition will be held on June 18, and six clerks will be selected for the work. Four of those selected must possess a satisfactory knowledge of mechanics, and two of chemistry.

City Notes.

Old Broad Street, June 12th, 1878.

THE holders of Telegraph Construction Shares will undoubtedly hope that the advance which has taken place, and which is naturally referred to in the June circular of Mr. William Abbott, may be "justified," whether the immediate cause is traceable or not traceable "to the fact that the Eastern Extension Telegraph Company have concluded an agreement with the Australian Government for the duplication of the company's line from Singapore.". If, as it is stated, the projected cable to the Cape of Good Hope is shortly undertaken, the Telegraph Construction shareholders may have additional cause for jubilation.

But we do not wonder that Mr. Abbott alludes in somewhat dubious terms to his dearly loved West India and Panama Company. It is indeed a fact—almost a notorious fact by this time—that the traffic receipts of the company have shown a decrease during the months of April and May, 1878, as compared with April and May, 1877; and it is equally true that the shares have "consequently declined." Mr. Abbott does pluck up hope enough to aver that "there is every reason to believe that the decline will be but temporary, as any revival in trade will immediately have a favourable effect upon the traffic returns." Exactly. But it is the revival in trade that we cannot as yet, at any rate, be sanguine about. The outlook at the present moment rather drives us to a conclusion that we have not seen the worst of the general depression; and, if that be so, we are afraid that the trade of the West Indies will not improve as speedily as the shareholders of the West India and Panama Company, and Mr. Abbott, desire.

At the recent meeting of the shareholders of Reuter's Telegram Company, the chairman, Colonel Holland, remarked that on the last occasion it was his duty to move the adoption of the most unsatisfactory report which had been issued since the formation of the company. He then, however, ventured to predict that things would be more satisfactory a year hence, and we are glad to be able to coincide with him that he was not unduly sanguine. As we briefly mentioned in our last issue, the company has paid a dividend of 7½ per cent. and carried forward to the reserve fund a considerable amount of the sum which last year the directors were compelled to take from it in order to declare a dividend at all. Nor did the chairman, like some chairmen we could name, attempt to put too bright a face upon the prospects or present position of the company. He only contended that there was now no reason to complain of the latter, and that the report should also encourage them concerning the former. It is a matter for regret that Baron de Reuter, whose name, justly observed Colonel Holland, is a household word both in England and throughout Europe, has been compelled, on account of failing health to retire from the part of managing director, but the shareholders may be heartily congratulated upon the fact that his son, Mr. Herbert de Reuter, has been appointed in his place.

The directors of the Brazilian Submarine Telegraph Company have declared an *interim* dividend for the quarter ended March 31st, of 20s. 6d. per share, or 5 per cent. per annum, free of income tax. Perhaps the directors will excuse us for observing that they have not been in any hurry to declare a dividend. This is the middle of the third month of another quarter.

It is notified by the Eastern Extension Telegraph Company that the repair of their Singapore-Saigon Cable is completed. Messages can now, therefore, be forwarded to China and Japan by that route.

The following are the latest quotations of telegraphs: Anglo-American, Limited, 62-62½; Ditto, Preferred, 91½-92¼; Ditto, Deferred, 34½-35½; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6¾-7; Cuba, Limited, 9¼-9¾; Cuba, Limited, 10 per cent. Preference, 15¾-16¼; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 9⅞-10; Direct United States Cable, Limited, 1877, 13⅝-13⅞; Eastern, Limited, 7½-7¾; Eastern, 6 per cent. Debentures, repayable October, 1883, 105-108; Eastern 5 per cent. Debentures, repayable August, 1887, 102-104; Eastern 6 per cent. Preference, 11⅝-11⅞; Eastern Extension, Australasian and China, Limited, 7⅝-7⅞; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; German Union Telegraph and Trust, 8-8½; Globe Telegraph and Trust, Limited, 5½-5⅝; Globe 6 per cent. Preference, 10⅝-10⅞; Great Northern, 8⅝-8⅞; Indo-European, Limited, 20-21; Mediterranean Extension, Limited, 2½-3; Mediterranean Extension, 8 per cent. Preference, 9¼-9¾; Reuter's, Limited, 10-11; Submarine, 221-226; Submarine Scrip, 2-2¼; West India and Panama, Limited, 2⅛-2⅜; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited, 5-5¼; Ditto, 6 per cent. Debentures "A," 98-101; Ditto, ditto, ditto, "S," 96-99; Western Union of U.S. 7 per cent, 1 Mortgage (Building) Bonds, 111-113; Ditto, 6 per cent. Sterling Bonds, 101-103; Telegraph Construction and Maintenance, Limited, 31-32; Ditto, 6 per cent. Bonds, 102-104; Ditto, Second Bonus Trust Certificates, 2⅝-2⅞; India Rubber and Gutta Percha and Telegraph Works, Limited, 24½-25½.

In the leading journal lately, attention has been directed to what our contemporary calls "the precarious position of the ordinary stock of our English railways," the position being due, our contemporary affirms, "to the want of system which has marked the treatment of their capital expenditure." We are compelled to admit that the case made out against the railway companies is decidedly damaging. Railway shareholders need not be panic-stricken at the facts and figures which the writer in the *Times* formulates; but, if they devote serious attention to them, it may be so much the better for them hereafter. Without doubt, many of the companies which pay the highest dividends are guilty of the sin of charging to capital what should be charged to revenue—and, sooner or later, Nemesis must overtake directors who allow such oose, not to say worse, account-keeping.

We had hoped that there would be no need for us to refer further to the London Chatham and Dover Railway Company. But it is usually amusing to hear the pot calling the kettle black, and a remark of one of the most furious opponents of the fusion scheme, that "it answered the purposes of adverse speculators to start a report that a large sum of money would be required to complete the Deal and Dover line, but, like most rumours of a similar nature, it has no foundation in fact;" it has, no doubt, been the cause of more than one smile. Possibly the "adverse speculators" were guilty of the sin laid to their charge, but what of the speculators who were not adverse, and whose purposes it answered and answers, to deny all rumours that are likely to affect the shares of the Chatham Company?

THE TELEGRAPHIC JOURNAL.
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THE CARBON TELEPHONE AND MICROPHONE.

As soon as the details of the microphone of Professor Hughes were published to the world, it was seen by those who were familiar with Edison's Carbon Telephone, that the two inventions were closely allied; and we are hardly surprised to learn that Mr. Edison has set up a claim for priority of invention of the microphone. Following a practice of his country, one of those admirable institutions we are sometimes called upon to admire, but which we are happy to say is not yet introduced amongst us, he has rushed into the public press and made his complaint there. Starting with the assumption that the microphone is essentially identical with the carbon telephone, his case is that Mr. W. H. Preece has committed a breach of confidence, inasmuch as Mr. Edison, at the desire of Mr. Preece, has kept the latter *au courant* with his inventions and experiments, including the carbon telephone, ever since they met in America last year. The Washington *Star*, of April 19, containing an account of his carbon telephone and thermo-pile, was sent by Mr. Edison to Mr. Preece, together with letters from time to time, and Mr. Edison has concluded that Mr. Preece betrayed his confidence to Professor Hughes. "I regard the conduct of Mr. Preece in this matter," says Edison in the *New York Tribune*, of June 8, "as not merely a violation of my rights as an inventor, but as a gross infringement of the confidence obtained under the guise of friendship." Telegrams to a similar effect have also been sent by Edison to Sir William Thomson, and to Mr. Preece himself, calling upon him to set the matter right with details. We deplore the hastiness with which these communications have been made public by Mr. Edison, and take slight exception to the language in which they are couched. It is otherwise, however, with some remarks in the *New York Herald*, of June 4, headed "Brain Stealing:—A most regrettable attempt to steal from Mr. Edison the honour of having invented the thermo-pile is being made in England, where, owing to the inventor's too free explanation of his plan, a knowledge of his secret was obtained. The fact that Mr. Edison trusted to the honour of a party who came out to investigate his inventions, and to whom he confided the particulars of this one, has enabled one of those scientists who could have shewn Columbus how to stand an egg on end after he had seen the great Captain do it, to come before the world claiming an invention on which Edison had been working successfully for a year or more." This quotation, although distinguished by that elegant taste and scrupulous devotion to truth so characteristic of American journalism, is, we trust, no more than the playful flight of a penny-a-liner.

Now, it appears to us, after a study of the subject in dispute, as it appeared at first, that Edison's assumption of the identity of the microphone discovery with his, is erroneous, and we shall presently give our reasons. But, even if they were the same, that fact is not sufficient ground for charging Mr. Preece with breach of confidence. Edison's English telephone patent, and many articles in American and other journals, have made his carbon telephone familiar to scientists, and especially electricians, in England and elsewhere, for nearly a year past. It appears to us almost preposterous to suppose that Professor Hughes required to learn from Mr. Preece about the carbon telephone—an instrument which has been familiar to all English electricians, worthy of the name, for at least nine months, and which was brought before the British Association by Mr. Preece himself in August, 1877. Professor Hughes has told us and shown us by his experiments, that the carbon telephone did not even suggest the microphone; but, even if it had been so, we fail to see that Mr. Edison would thereby be justified in charging Mr. Preece as he has done. It is no secret that Professor Hughes, after making the first articulating microphone, went on in a truly scientific manner, maturing the subject for three months more, ere he communicated his results to anyone at all. The fact that no patent has been taken out, and no gain desired, is an argument in itself against the charge.

It is an error of the American Press to take it for granted that Edison's Telephone suggested the microphone. Professor Hughes has shown in the clearest manner that it was Sir William Thomson's discovery that extension and compression of iron wires altered their electric resistance. This being so, it occurred to Hughes that it might be possible to make the wire itself of a telephone circuit transmit vocal wave currents, by causing the sonorous vibrations of speech to extend and compress it. He therefore tried a piece of wire in a telephone circuit, by plucking it, but with no result, until the wire was strained to the point of breaking, when a grating noise was heard in the telephone, followed by a loud tick, when it broke. This led him to the conclusion, which is the pith of the distinction, between the microphone and carbon telephone. Finding the wire sonorous when in a condition of rupture, he put the broken ends together again under a slight pressure, and, to his joy, discovered that the imperfect joint so obtained could transmit sound, and

was, in fact, a rude microphone. The discovery became clearer on further experiment. It was found to lie in a peculiar property of the mechanical contact of two conductors, which rendered them proportionately sensitive to sonorous or other molecular vibrations. The merit of Professor Hughes' discovery mainly consists in this—that it is a property of the *contact* of two conductors, and that it is not confined to any one, but to all conductors. Edison's claim has been until now, and can only be stated as follows :—"I discovered about two years ago that carbon of various forms, such as plumbago, graphite, gas retort, carbon and lampblack, when moulded in buttons, decreased the resistance to the passage of the electrical current by pressure," (we give his own words). This was an important discovery, but it had been anticipated by M. Clerac, of the French Telegraphic Administration, Paris, who as long ago as 1866, constructed tubes containing powdered carbon, the electric resistance of which, could be regulated by increasing or diminishing the pressure upon it by means of an adjusting screw. Mr. Edison applied it to his carbon telephone in a manner well-known. Now it appears to us, from all accounts, that Mr. Edison, though very nearly discovering the full significance of the microphone, did not do so. He explained the real nature of the property which he had found to exist in carbon and, let us say, the vague but all-comprehensive patent-phrase, "finely divided metals" to be a diminution of resistance in the *mass* of the material. The discovery of the microphone limits it to an effect of the *surfaces of contact;* but it is plain that Edison did not find this out, else we have no hesitation in saying so great an inventor would not have confined himself to buttons of carbon placed between platinum discs. Thus it is that Professor Hughes' discovery explains the true action of Edison's telephone, which is indeed a form, but a disguised form, of the microphone. It may enable the former to rid itself of its mask, and in addition it opens up a wide field of investigation in which other inventions and discoveries now lie hid.

We have not dwelt at length on the power of the microphone for interpreting otherwise inaudible sounds; but that power is sufficiently remarkable to give further evidence that Mr. Edison did not discover the microphone. As for the thermo-pile, we have seen it incidentally mentioned by Professor Hughes that the microphone is extremely sensitive to heat; but we have not understood him to claim the invention of a thermo-pile founded upon this property. We are aware that inventors have carefully to guard the productions of their genius from the piracy of others; but the history of invention indicates that an over-sensitiveness on this point is too common amongst them. The inventor, like the man of science, should content himself with labouring by the method of Faraday, "work, finish, publish," leaving it to the world to judge his achievements. We therefore regret to see an inventor, fast becoming illustrious, rashly posing himself in the newspapers; but we hope that his doing so is rather the fault of his advisers, and of the custom of his country, than of himself.

The following messages have been sent to New York :—

"Sir,—Pray give the most absolute and unqualified denial to the statements made by Edison respecting me. Hughes has not brought out any thermo-pile. His microphone is quite a different instrument to Edison's telephone. It was worked out without any communication with me, or information imparted by me in any way whatever. I knew nothing of it until it was shown to me, together with Prof. Huxley and Mr. Norman Lockyer. I am in no way whatever a coadjutor of Hughes.

W. H. Preece."

"I emphatically endorse every word of the above message.

D. E. Hughes."

We have also received the following letter from Professor Hughes :—

To the Editor of the Telegraphic Journal.

Dear Sir,—I notice with regret that Mr. Edison has been trying to make the American public believe that he also invented the microphone, and that, simply because in his carbon telephone he made use of a button of carbon, the varying pressure of a diaphragm upon which produces a varying current of electricity! In all his attempts, as far as I can learn, he has never varied from this idea; he has made thin and thick diaphragms, tried many kinds of carbon, &c., but in all, the principle remains the same. The use of carbon, as a varying resistance with varying pressure, is not original with Mr. Edison. Mr. Clerac, Electrician of the French Telegraph Department, supplied me with resistance tubes founded upon this principle in 1866, viz., a glass tube containing powdered carbon, the resistance of which was regulated by the varying pressure of a regulating screw pressing on the carbon. Mr. Edison claims this resistance tube as an original invention or discovery in 1873, or seven years after it was known in Europe; and he will find in the *Journal Telegraphique*, Berne, 1873, that the invention was claimed by a German, but on Mr. Clerac's proving his priority, 1866, it was freely accorded him. So much for the resistance carbon tubes of Mr. Edison, and the principle of which he acknowledges he has adopted in his carbon telephone. As a coincidence, it is curious that the date, 1873, of Mr. Edison's claim to these resistance tubes should be the same when the invention of 1866 was again brought prominently into notice by the remarks in the *Journal Telegraphique*.

I am willing to believe Mr. Edison was ignorant of these facts until the present time, but he ought now to investigate them, and give credit where it is due.

The microphone which, with the numerous forms now in use, after many months of inces-

sant labour and study I discovered and invented, is entirely different in principle, action, form, uses, and results to the carbon transmitter of Edison, or to Professor Bell's telephone. There is no diaphragm thick or thin, there is no mechanical apparatus by which the sounds are directed or concentrated upon the electrical conducting material; no arrangement to obtain a varying pressure, as we need really a constant one; there is not the slightest necessity for the use of carbon at the contact points, as all metals which do not oxydise act equally well. The sonorous vibrations are taken up by a piece of pine board, or other resonant material, and if on any part of this board, no matter how distant from the speaker or source of sound, two electrical conductors are placed under a very slight but constant pressure; these conductors vibrate exactly as the molecular agitation or vibration of the board and of themselves. Without any regulation, without any change of pressure, a constant electric current is transformed into waves exactly similar in form with the sonorous vibrations. The effect is wonderful, so much so, that the highest scientific intellects of Europe have been struck with surprise and astonishment that such unheard of effects could be produced from an apparatus and causes so apparently simple.

In some of the forms of microphones, I use carbon at the contact points; and, if I believed, for a single instant, that Mr. Edison was the first to use carbon for electrical purposes or for contact points, I would use platina or gold points, which are equal, if not superior, though not so cheap; but, as carbon has long been used in electrical batteries, electric light, resistance tubes, and relay contacts, by myself, I see no necessity to abandon its use simply because Mr. Edison happens to use it in his carbon telephone, in a totally different way, and for different reasons from its use as contact points in the microphone.

An assistant of Mr. Edison, Mr. Adams, presented to the Post Office Telegraphs, about eight weeks since, the latest form of Edison's Carbon Telephone, and, as it was publicly exhibited, I saw it in company with many others. It consisted of an Edison transmitter, and an exact copy of Professor Bell's receiver, which he called an Edison receiver.

The transmitter consisted of a diaphragm (of the same form and materials as Professor Bell's) pressing upon a button of carbon, the varying pressure of the diaphragm upon the carbon producing a varying current of electricity. It was complicated, required not only the use of batteries, but induction coils, and the results were inferior to those of Professor Bell's, against which it was tried in my presence. The Edison receiver was identically the same as Professor Bell's, the only difference being that the natural magnet was brought round so as to touch the diaphragm, in fact, it was so transparent a device to infringe Bell's patent, that the Bell Company at once said they would not permit its use.

If Mr. Edison thinks there are points of resemblance between his carbon transmitter and Professor Bell's Telephone, and anything I have done, it is quite a proper subject for discussion in the scientific journals, but quite unsuitable (being one of a technical nature) for discussion in public journals of general interest; and the technical part of the question must henceforth be discussed by those who, in full possession of the facts, are capable of judging.

But Mr. Edison has made, publicly, a gross personal attack upon the honour of Mr. Preece and myself, and this part he must prove as publicly as he has made it, or stand confessed a wilful slanderer. His message to Sir William Thomson, London, says:—"Edison to Sir W. Thomson. Direct impact carbon telephone sent Preece two months ago, also publications and letters describing its use as heat measurer—great abuse of confidence on his part in Hughes' matter. I send you publications of proofs."

This message seems carefully worded, although it insinuates an abuse of confidence on Mr. Preece's part.

The carbon telephone received through his agent, Mr. Adams, two months since, I have already mentioned, but I had already shown mine some weeks before its arrival at the Post Office, and had tried them in February at the Submarine Telegraph Company, in the presence of its officers. There has been no secret as to the effects of my microphone since last February, but the secret was divulged for the first time in presence of Prof. Huxley, Mr. Norman Lockyer, and Mr. Preece, May 2nd, when it was decided to read a paper upon my discoveries of the last six months, which was done the following week. Mr. Preece could see no resemblance, then nor since, between my microphone and Edison's carbon telephone, and consequently had no confidences to make me, even if he had any from Edison, which I do not believe he had; but even supposing he had informed me then that Mr. Edison was also trying to make a microphone, it would not have prevented me from at once presenting to the world the microphone I had discovered, made, and exhibited at the Submarine Telegraph Company many months before. So it was a gratuitous insult to Mr. Preece and myself to insinuate that simply because he sent a carbon transmitter to the Post Office for trial through his own agent, Mr. Adams, that I should have taken hints from such a failure as it proved to be—to improve that which had already been found successful months before. It bore no resemblance to the microphone in its objects and effects. The main object of Edison's telephone appeared to me to be to avoid Prof. Bell's magnetic transmitter by producing the same effects of telephony in a different way. The main object of the microphone is to render sounds audible hitherto inaudible, and thus to allow us to investigate a new field hitherto unexplored. A mere glimpse, or in fact, a long study, of Edison's carbon-transmitter would not have helped the matter in the slightest. Had I been inclined to imitate, it would certainly have thrown me on the wrong track, as it did him.

Mr. Edison, however, has gone still further. He has sent to the French journals, and published in *Figaro*, June 24, and *Correspondance Scientifique*, June 25, the following, which he declares that he sent to Sir William Thomson.

Edison to Sir William Thomson:—"J'ai envoyé des microphones à MM. Preece et Hughes, il y à deux mois et aussi des déscriptions de cet appareil, il y à abus de confiance de la part de M. Hughes dans cette affaire, attendez mes preuves. —Menlo Park, Juin, 1878.—EDISON."

[TRANSLATION.]

Edison to Sir William Thompson:—"I have sent some microphones to Messrs. Preece and Hughes

two months since, and also some descriptions of that instrument. There is an abuse of confidence on the part of Mr. Hughes in that affair. Await my proofs.—EDISON."

This will be seen to be very differently worded to the one really sent Sir William Thomson, and states directly that he sent me microphones, and that I abused his confidence.

In answer I have only to say that I have never received any microphones, any carbon telephones, any instrument, any description, letter, or communication from him, direct, or indirect, at any time whatever. This I state emphatically, and now call on Mr. Edison to prove the truth of his message I have just quoted from the French journals, and that no further technical discussion can take place until he furnishes such proof.

If he fails in proving the truth of the above message, as he surely will, his conduct will merit the contempt it will receive. D. E. HUGHES.

London, June 27th, 1878.

THE TELEPHONE.

By M. DU BOIS-RAYMOND.

THE telephone has for the physiology of language an importance which has not as yet been sufficiently taken into consideration; also the true explanation of the manner in which it works has not been yet published.

It is this explanation which we will now give as simply as possible, the construction of the telephone of Graham Bell being supposed to be understood.

According to M. Helmholtz, we distinguish a particular quality in a sound, because this sound results from elementary wave vibrations of which the respective periods and the amplitudes are different and determined. And it is not necessary to consider the position which the different waves occupy on the axis of the abscissæ, or the form which the resultant curve necessarily has. This theory has its origin in the theory of the specific energies of nerves under the form which M. Helmholtz has given it, according to which a single nerve-cord only allows of the distinction of differences of quantity in the impressions.

Since certain auditory nerve cords are excited by certain respective intensities, we can distinguish a particular quality, whatever may be the phases of the waves corresponding to the vibrations of the extremities of these cords, which coincide in time, or as we say, whatever may be the differences of the phases of these waves.

In order to understand how, in listening to telephone B, we hear what is said in telephone A, it is sufficient to suppose that an elementary wave vibration of the sound which agitates the air in A, communicates itself to the air which surrounds B, under the form of an elementary wave vibration of a proportional amplitude and of the same duration.

The fact that, under the influence of the wave vibrations of the surrounding air, the iron membrane of A executes similar vibrations, does not require explanation. The smallness of the movements of the membrane allows them to be regarded as sensibly proportional to the variations which take place in the magnetic potential of the membrane, and of the magnet within the bobbin. Thus, for a particular wave vibration of the membrane, this potential varies with the time, and is proportional to a wave which has equal duration, and which, with respect to the other waves of similar sound, has the same relative amplitude as the particular vibration of the membrane and of the air surrounding it.

Let P be this potential, then

$$P = \text{const.} \sin t.$$

The variations of P induce in the coil currents whose electro-motive force is at each moment proportional to $\frac{dP}{dt}$. But we have $\frac{dP}{dt} = \text{const.} \cos t$, from which it follows that the wave movement of the air in front of the membrane produces in the conducting wave of the telephone a current which, in lessening the induction of the wave on itself, is represented in the time by a depression, that is to say by a wave displaced by $\frac{\pi}{2}$ over the axis of the abscissæ. This current produces in its turn a variation of the power of the magnet in B, a variation which, from known observations, is proportional to the power of the current which produces it. It produces in its turn in the membrane B and the air-surrounding, movements which are still proportional to it, considering their smallness.

Thus all the elementary wave vibrations which constitute a given sound, transmit themselves from one membrane to the other with their durations and their amplitudes relative, because from the fundamental principle of electric induction, wave vibrations in space produce depressions of the current in the time. But it should be remarked that, in consequence of this transformation, the phases of the different waves which coincide at the moment of excitation of the induction current, are completely turned over, each wave being displaced for a quarter of its length, so that the form of the resultant curve for the air which limits B, becomes altogether different from that which represents the movement of the air in A.

The possibility of a correspondence by the telephone thus rests upon two circumstances:—firstly, the particular form which connects the force of induction with the variation in potential; secondly, the fact that the quality is independent of the difference of the phases of the waves which compose the sound.

In his celebrated researches on vocal synthesis, M. Helmholtz has shown this independence in a rather complicated manner, either by tuning forks put out of tune in order to obtain differences of phases, or by reversing the current in the electro-magnet of his tuning forks.

A simple and efficient means of showing this fact at a lecture, consists in setting in vibration with a bow two tuning-forks of König, giving ut_3 and ut_4, and sharply silencing the second. The quality of the tone then passes suddenly from *å* to *ou*, and that in a manner strikingly independent of the difference of the phase which, in this manner of operating, cannot happen twice the same. But it is impossible after all, to have a more striking proof in favour of the theory of M. Helmholtz than the fact of the possibility of the transmission of quality by the telephone.

Although we have up to the present only spoken of musical sounds, which alone are formed of regular waves, what we have said still applies with sufficient exactitude to the irregular vibrations of noise.

The theory of the telephone does not then involve any new principle, and the phenomena do not present anything beyond what was already known. The existing theories would, therefore, have been sufficient to have led to the invention of the telephone some time ago. But that which anyone cannot forsee, and that which always astonishes, even now that the telephone exists, is the rapidity with which these actions are propagated. This remarkable example of a double transformation of forces producing a final loss of mechanical energy also small, still shows at once what many facts have already indicated: that is, that in the propagation of molecular actions, there is less force transformed into heat than is the case when the transmission from one mass to another is accompanied by movements.

Under these circumstances, it appears that we must take pains to study otherwise than by audition, the electric currents in the wire of the telephone. As it acts by alternate currents, their actions on the magnetic needle would be inappreciable; but the electro-dynamometer of Weber would be able to show these currents, and enable their power from different sounds to be studied.

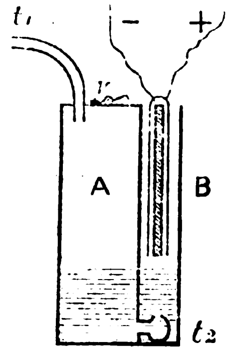
There is still a method of studying these currents. As M. Grassmann has shown, the currents induced by musical vibrations from a magnetized bar affect a frog's leg galvanoscope. It is easy, then, to obtain the same results from telephonic currents. It is sufficient, in the place of attaching the two extremities of the wire to the terminals of B, to put them in communication with those of the moistened exciting tube, on the electrodes of which the nerve rests; then the leg shows the shocks immediately anyone speaks, sings, or whistles in telephone A, or even if the mouthpiece of latter is placed a little roughly on the table. It can be seen at the same time that the nerve is more sensitive to certain sounds than to others. If anyone cries *zücke* (contract) to the instrument, the leg of the frog commences to move; on the first *i* of *liege still* (keep still) it does not move. The sounds which have characteristic harmonic basses act more vigorously than those which are higher; so, in the experiments of M. Grassmann, the bar vibrating transversely about its middle, acts more strongly than when it vibrates in nodes.—*Archives des Sciences Physiques de Genève.*

A PORTABLE BYRNE'S PNEUMATIC BATTERY.

By H. R. KEMPE.

THE inconvenience in this battery, of having to lift the plates out of the exciting solution when the battery is not required for use, is well known; and no attempt, so far as I know, has been made to get rid of it. The following arrangement has suggested itself to me as a good method of remedying the inconvenience:—

Each battery cell is divided into two chambers, A and B; the former is closed in air-tight at the top, the latter is open, and contains the battery plates, to which the leading wires — and + are attached. The plates do not reach to the bottom of the cell, but to a distance proportionate to the relative sizes of the chambers A and B: thus, if A and B are made equal, the plates would reach only half-way down; if A is twice as large as B, the plates would then reach two-thirds down. t_1 is the air-tube through which the air from the bellows is blown when the battery is to be put in action; t_2 is the ordinary perforated tube in the usual form of the battery; this tube is connected to the chamber A, as shown in the fig. The solution is poured into the cells so as to fill them nearly to the height of the plates, a valve, *v*, being kept open so as to allow the level of the liquids in the two chambers to be normally equal.



The action of the apparatus is almost obvious: on blowing through tube *t*, the air forces out the liquid from A, through t_2, into B, and fills the latter; when all the liquid is drawn out of A, the air continually supplied through t_1 bubbles up through t_2, and excites the battery in the ordinary manner.

When the use of the battery is to be discontinued, the valve, *v*, is opened for an instant, and the liquid again retreats into A, and uncovers the plates.

ELECTRIC TELEGRAPHY AT THE UNIVERSAL EXHIBITION OF 1878.

By LE COMTE DU MONCEL.

(*Continued from page* 248.)

LIKE that of M. Baudot, to which it gave rise, this system is based upon the successive transmission of signals made by several *employés* at the same instant, and which a distributor mechanically sends through the line one after another, but in such a manner that each one is received only by the proper receiver. To this end the two distributors at the two stations travel synchronously and establish between the manipulators and receivers, which should travel together, momentary electric connections which permit the combinations for each of the signals to be reproduced.

The signals sent in this system are those of the Morse alphabet, and the elementary ones intended to produce them must be made simultaneously in order that the entire signal, that is the letter, may be presented to the transmitting apparatus quite prepared. For this purpose each manipulator is composed of eight keys, arranged like those of a piano, the whites corresponding to the dashes and the blacks to the dots of the Morse alphabet; and each section of the distributor worked by one *employé* is furnished with eight contacts, alternating with four non-contact pieces, and spread over a more or less extended arc, on a circular disc of

ebonite which constitutes the distributor and carries the contact of all the sections. If the apparatus is intended for six transmissions, this disc carries forty-eight contacts, or sixty-four if for eight transmissions. These contacts are grouped in pairs, and are joined by wires to the keys of the corresponding manipulator, so that when a white key is depressed the battery is put in simultaneous communication with two contiguous contacts; when a black key is depressed the battery communicates with only one contact. Thus as the contact-maker of the distributor which passes over all the contacts transmits currents of twice the duration for a white key that it does for a black key, it follows that dots and dashes are obtained on the receiver, according to the nature of the key depressed. The insulating spaces placed between the contacts naturally correspond to spaces which separate the signals, dots or dashes.

It is now easily understood that on depressing simultaneously the number of black and white keys, necessary for the formation of a letter (starting from the left), at the exact moment that the contact maker arrives at the corresponding portion of the distributor, and keeping the keys depressed for a few moments, the interruptor will produce successively, by its passage over the different contacts, the number of long and short currents necessary for the formation of the letter on the corresponding receiver, so that the impression of this letter takes place in consequence of a manipulation made at one stroke.

The receiver, corresponding to each manipulator, is somewhat similar in arrangement to the Morse receiver, but the tracer, instead of being a disc (or rowel), is a cylinder, furnished with a projecting lever in form of a helix, but presenting for each apparatus only a fraction of a complete helix, which fraction may be one-fourth, one-sixth, or one-eighth, according to the number of transmissions intended to be accomplished; and the position of this portion of the helix on the cylinders is such that each one is the sequel to the preceding one, so that all these spiral portions, if brought together, would make up one complete spiral.

The helix of the receivers, and the contact maker of the distributor, perform their revolutions in the same time, the latter passing over the first section of the distributor while the first spiral progresses in front of the strip of paper which passes underneath and which is to receive the message; and so with the others. An inking-pad turns freely on each of the helices; and underneath the paper band is placed a sharp-edged lever-frame, which when actuated by an electro-magnet carries the paper to the inked helix at the moments of closing of the circuit, producing impressions, of which each portion is relative to the point of the projecting helix at that moment before the paper; so that these impressions may be long or short accordingly as they are isolated or juxtaposed. As the position of the different points of the projecting helix answers exactly to that of the contacts of each section of the distributor, the marks produced are an exact reproduction of the signals sent.

In the Meyer receivers the axis of the projecting helix is perpendicular to the length of the paper band, so that all the elementary signals composing one letter are produced transversely with regard to the paper, and appear one under the other. In reading, therefore, it is necessary to pass the eye vertically up the band as it travels before one.

It will be understood, however, that to obtain a regular action with these instruments, the essential condition is a perfect synchronism between the corresponding distributors and the receivers connected with them. As the receivers are in mechanical relation as to motion with the distributor, their synchronism can be easily effected; but it is not so with the distributors, and M. Meyer has had to devise a special system, which has succeeded perfectly and which does the greatest honour to the inventive genius of its author, and also to the ability of M. Hardy, the constructor of the apparatus. It would be difficult to explain this ingenious device without figures, but its description is in no way necessary to a comprehension of M. Meyer's system.

APPARATUS FOR INDICATING THE OUTBREAK OF FIRE IN SHIPS' CARGOES.

By F. HIGGINS.

THIS apparatus, which is patented, consists of an indicator for the captain's cabin connected by wires to thermostats placed on the beams or stanchions of vessels, or in such other positions as may be necessitated by the nature of the cargo.

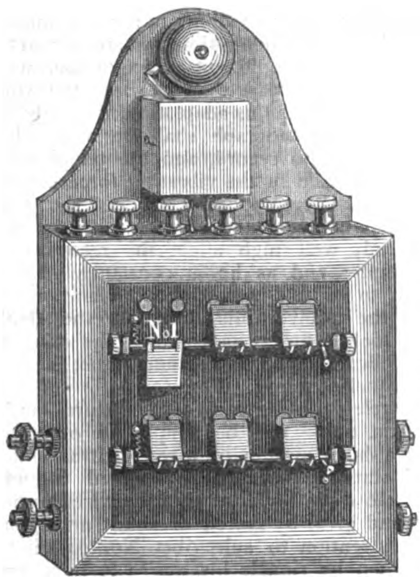
This system differs from those hitherto suggested for this purpose, in the manner of giving the alarm and in the connections. A current from a battery is caused to flow through an electrical circuit composed of an electro-magnet and one or more thermostats. As long as the circuit is complete, a kind of shutter on the indicator dial is upheld by the electro-magnet, but upon an increase of temperature taking place the circuit is opened by the thermostats, the shutter is released, and falls by gravitation, thus exposing to view the number of the section of the ship in which the thermostats are placed, and at the same time causing a trembler bell to ring. This ringing continues until stopped by hand.

The reason for the employment of a normally closed circuit, the continuity of which is intended to be ruptured by any abnormal temperatue, is, that circuits normally open give no indication of a breakage of the conductor, and may fail to announce a rise of temperature from many other causes. Such arrangements also require to be tested constantly, and from the fact of the most important part of the system being inaccessible, there would be a chance of the apparatus failing to perform its duty.

This element of unreliability is eliminated from the present apparatus, and any accident to the conductor or battery would announce itself immediately upon its occurrence, and thus afford an opportunity for repair, or, if that should not be possible at sea, it would simply leave the damaged section negatively protected; for in case of an outbreak of fire not being announced from protected sections, it would obviously be in the one unprotected.

The chief object of this system is not, however, to announce an actual outbreak, but to give warning of dangerous heating. The thermostats consist

of a compound bar of zinc and steel, or a spiral of brass and steel enclosed in a tube, one end being fixed and the free end resting at ordinary temperatures upon a contact piece. The zinc and steel combination is the most sensitive and performs very well if the zinc be annealed in boiling water and the contact arranged with a spring so as to relieve the zinc from any strain. Without the latter precaution the zinc will give way in course of time, and the bar lose its original adjustment.



A rise of 20° F. will cause the free end of such a bar $4\frac{1}{2}$ in. long to move $\frac{3}{16}$ in. from its contact point, there is, therefore, sufficient movement and force to ensure correct performance.

For a large ship, with 18 thermostats, a battery of two bichromate cells would be employed, and would be of sufficient capacity to furnish the necessary power for six months. Should it become necessary to recharge the batteries at sea, no difficulty would be experienced in doing so. Much more difficult operations are readily undertaken by captains of ships.

The drawing shows the arrangement. The two binding screws at the right side connect the battery with bell, those on the left give connection with the electro-magnets, and the six screws on the upper part of the indicator are for connecting up the thermostats.

THE PHONOGRAPH AND ITS FUTURE.

By T. A. EDISON. *

(*Continued from page* 251.)

THE foregoing presentment of the stage of development reached by the several essential features of the phonograph demonstrates the following as *faits accomplis:*

1. The captivity of all manner of sound waves heretofore designated as "fugitive," and their permanent retention.

2. Their reproduction with all their original characteristics at will without the presence or consent of the original source, and after the lapse of any period of time.

3. The transmission of such captive sounds through the ordinary channels of commercial intercourse and trade in material form, for purposes of communication or as merchantable goods.

4. Indefinite multiplication and preservation of such sounds without regard to the existence or non-existence of the original source.

5. The captivation of sounds, with or without the knowledge or consent of the source of their origin.

The probable applications of these properties of the phonograph and the various branches of commercial and scientific industry presently indicated will require the exercise of more or less mechanical ingenuity. Conceding that the apparatus is practically perfected in so far as the faithful reproduction of sound is concerned, many of the following applications will be made the moment the new form of apparatus, which the writer is now about completing, is finished. These then might be classed as actualities; but they so closely trench upon other applications which will immediately follow, that it is impossible to separate them: hence they are all enumerated under the head of probabilities, and each specially considered. Among the more important may be mentioned letter-writing and other forms of dictation books, education, reader, music, family record, and such electrotype applications as books, musical boxes, toys, clocks, advertising and signalling apparatus, speeches, &c., &c.

Letter-writing.—The apparatus now being perfected in mechanical details will be the standard phonograph, and may be used for all purposes, except such as require special forms of matrix, such as toys, clocks, &c., for an indefinite repetition of the same thing. The main utility of the phonograph, however, being for the purpose of letter-writing and other forms of dictation, the design is made with a view to its utility for that purpose.

"The general principles of construction are a flat plate or disc, with spiral groove on the face, operated by clock-work underneath the plate; the grooves are cut very closely together, so as to give a great total length to each inch of surface—a close calculation gives as the capacity of each sheet of foil, upon which the record is had, in the neighbourhood of 40,000 words. The sheets being but ten inches square, the cost is so trifling that 100 words might be put upon a single sheet economically.

"The practical application of this form of phonograph for communications is very simple. A sheet of foil is placed in the phonograph, the clock-work set in motion, and the matter dictated into the mouth-piece without other effort than when dictating to a stenographer. It is then removed, placed in a suitable form of envelope, and sent through the ordinary channels to the correspondent for whom designed. He placing it upon his phonograph, starts his clock-work and *listens* to what his correspondent has to say. Inasmuch as it gives the tone of voice of his correspondent, it is *identified*. As it may be filed away as other letters, and at any subsequent time reproduced, it is a perfect *record*. As two sheets of foil have been indented with the same facility as a single sheet, the 'writer' may thus *keep a duplicate* of his communication."

As the principal of a business house, or his

* From *The North American Review*, May-June, 1878.

partners now dictate the important business communication to clerks to be written out, they are required to do no more by the phonographic method, and do thereby *dispense with the clerk*, and *maintain perfect privacy* in their communications.

"The phonograph letters may be dictated at home, or in the office of a friend, the *presence* of a stenographer *not being required*. The dictation may be as rapid as the thoughts can be formed, or the lips utter them. The recipient may listen to his letters being read at a rate of from 150 to 200 words per minute, and at the same time busy himself about other matters. Interjections, explanations, emphasis, exclamations, &c., may be thrown into such letters *ad libitum*."

In the early days of the phonograph, ere it has become universally adopted, a correspondent in Hong Kong may possibly not be supplied with an apparatus, thus necessitating a written letter of the old-fashioned sort. In that case the writer would use his phonograph simply as a dictating machine, his clerk writing it out from the phonograph at leisure, causing as many words to be uttered at one time as his memory was capable of retaining until he had written them down. This clerk need not be a stenographer, nor need he have been present when the letter was dictated.

"The advantages of such an innovation upon the present slow, tedious, and costly methods are too numerous, and too readily suggest themselves, to warrant their enumeration, while there are no disadvantages which will not disappear coincident with the general introduction of the new method."

Mr. Edison then points out that all kinds of dictation may be readily effected with the delicate phonograph which is in the near future. The utterances of court and parliament will be recorded; and the newspaper printer will read by ear, using his eyes for the type exclusively. Books will be read mechanically to patients or others whose eyes are engaged over work in the style of excellent elocutionists. As a teacher of elocution, pronunciation, and spelling, the phonograph will be useful. It will also teach and perform music, preserve the voices of dead friends and the sounds of dead languages. The *quality* of the voice is the only element which may not be perfectly reproduced. Toy animals and dolls shall give their characteristic sounds. Clocks shall announce the hours *viva voce*, call to lunch, &c., and advertising shall be carried on by phonograph.

"Lastly, and in quite another direction, the phonograph will *perfect the telephone*, and revolutionise present *systems of telegraphy*. That useful invention is now restricted in its field of operation by reason of the fact that it is a means of communication which leaves no record of its transactions, thus restricting its use to simple conversational chit-chat, and such unimportant details of business as are not considered of sufficient importance to record. Were this different, and our telephone conversation automatically recorded, we should find the reverse of the present status of the telephone. It would be expressly resorted to *as* a means of perfect record.

"'How can this application be made?' will probably be asked by those unfamiliar with either the telephone or phonograph.

"Both these inventions cause a plate or disc to vibrate, and thus produce sound-waves in harmony with those of the voice of the speaker. A very simple device may be made by which the one vibrating disc may be made to do duty for both the telephone and the phonograph, thus enabling the speaker to *simultaneously transmit and record his message*. What system of telegraphy can approach that? A similar combination at the distant end of the wire enables the correspondent, if he is present, *to hear it while it is being recorded*. Thus we have a mere passage of words for the action, but a complete and durable record of those words as the result of that action. Can economy of time or money go further than to annihilate time and space, and bottle up for posterity the mere utterance of man, without other effort on his part than to speak the words?"

In order to make this adaptation, it is only requisite that the phonograph shall be made slightly more sensitive to record, and the telephone very slightly increased in the vibrating force of the receiver, and it is accomplished. Indeed, the "Carbon telephone invented and perfected by the writer, will already well nigh affect the record on the phonograph; and as he is constantly improving upon it, to cause a more decided vibration of the plate of the receiver, this addition to the telephone may be looked for coincident with the other practical applications of the phonograph, and with almost equal certainty.

"The telegraph company of the future—and that no distant one—will be simply an organization having a huge system of wires, central and subcentral stations, managed by skilled attendants, whose sole duty it will be to keep wires in proper repair, and give, by switch or shunt arrangement, prompt attention to subscriber No. 923 in New York, when he signals his desire to have private communication with subscriber No. 1001 in Boston, for three minutes. The minor and totally inconsequent details which seems to arise as to obstacles in the eyes of the groove-travelling telegraph man, wedded to existing methods, will wholly disappear before that remorseless Juggernaut—'the needs of man;' for, will not the necessities of man surmount trifles in order to reap the full benefit of an invention which practically brings him face to face with whom he will; and, better still, doing the work of a conscientious and infallible scribe?"

Mr. Edison is certainly very hopeful of the future of the wonderful instrument he has invented, but we think, not too hopeful; for, after the invention itself and its most recent development, the microphone, it would be rash to say that any application of it is impossible. Certainly some substitute or substitutes for the clumsy mode of recording our thoughts by pen and ink, so inconsistent with the general rapidity of our time, must be close at hand; and what form one of these substitutes may take seems pretty clearly pointed out by the actual uses to which Mr. Edison's invention has been put.

EDISON'S THERMO-PILE.

ONE of Mr. Edison's latest inventive effusions is the carbon thermo-pile. It is based on the principle of the carbon telephone, now so well elucidated by the microphone. The sensitive part consists of a cube of prepared carbon or charcoal, confined between

two thin iron plates, and a fine slip of horn or quill, inserted between the second plate, and a third metal plate or clamp. This sensitive arrangement is connected in circuit with a battery, and a galvanometer. When heat-rays are allowed to fall on the slip of horn, it expands lengthwise and presses on the charcoal, reducing the electric resistance of the latter proportionately to the pressure. There is thus a corresponding rush of electricity through the circuit, causing a deflection on the galvanometer. The arrangement is exceedingly sensitive, the heat emanating from the hand being sufficient to give a deflection of 10°, with a single cell, through a galvanometer of about 2000 ohms resistance. It is said that Mr. Edison hopes to measure the heat from the fixed stars with it.

PROFESSOR CLERK-MAXWELL ON THE TELEPHONE.

(*Continued from page* 252.)

ONE great beauty of Professor Bell's invention is that the instruments at the two ends of the line are precisely alike. When the tin plate of the transmitter approaches the core of its bobbin, it produces a current in the circuit, which has also to circulate round the bobbin of the receiver, and thus the core of the receiver is rendered more or less magnetic, and attracts its tin plate with greater or smaller force. Thus the tin plate of the receiver reproduces on a smaller scale, but with perfect fidelity, every motion of the tin plate of the transmitter.

This perfect symmetry of the whole apparatus—the wire in the middle, the two telephones at the end of the wire and the two gossips at the ends of the telephones—may be very fascinating to a mere mathematician, but it would not satisfy an evolutionist of the Spenserian type, who would consider anything with both ends alike to be an organism of a very low type, which must have its functions differentiated before any satisfactory integration can take place.

Accordingly, many attempts have been made by differentiating the function of the transmitter from that of the receiver to overcome the principal limitation to the power of the telephone. As long as the human voice is the sole motive power of the apparatus, it is manifest that what is heard at one end must be fainter than what is spoken at the other. But if the vibration set up by the voice is used no longer as the source of energy, but merely as a means of modulating the strength of a current produced by a voltaic battery, then there will be no necessary limitation of the intensity of the resulting sound, so that what is whispered to the transmitter may be proclaimed *ore rotundo* by the receiver.

A result of this kind has already been obtained by Mr. Edison, by means of a transmitter in which the sound vibrations produce a varying pressure on a piece of carbon, which forms part of the electric circuit. The greater the pressure, the smaller is the resistance due to the insertion of the carbon, and, therefore, the greater is the current in the circuit.

I have said that the telephone is an instance of the benefit to be derived from the cross-fertilization of the sciences. Now, this is an operation which cannot be performed by merely collecting treatises on the different sciences, and binding them up into an encyclopædia. Science exists only in the mind, and the union of the sciences can take place only in a living person.

Now, Professor Graham Bell, the inventor of the telephone, is not an electrician who has found out how to make a tin plate speak, but a speaker who, to gain his private ends, has become an electrician. He is the son of a very remarkable man, Alexander Melville Bell, author of a book called "Visible Speech," and of other works relating to pronunciation; in fact, his whole life has been employed in teaching people to speak. He brought the art to such perfection that, though a Scotchman, he taught himself in six months to speak English. Mr. Melville Bell has made a complete analysis and classification of all the sounds capable of being uttered by the human voice, from the Zulu clicks to coughing and sneezing; and he has embodied his results in a system of symbols, the elements of which are not taken from any existing alphabet, but are founded on the different configurations of the organs of speech.

The inventor of the telephone, who had assisted his father, was thus prepared, by early training in the practical analysis of the elements of speech, to associate whatever scientific knowledge he might afterwards acquire with those elementary sensations and actions, which each of us must learn for himself, because they lie too deep within us to be described to others. This training was put to a very severe test when, at the request of the Boston Board of Education, Professor Graham Bell conducted a series of experiments with his father's system, in the Boston School for the Deaf and Dumb. I cannot conceive a nobler application of the scientific analysis of speech than that by which it enables those to whom all sound is

> "expunged and razed,
> And wisdom at one entrance quite shut out,"

not only to speak themselves, but to read by sight what other people are saying. The successful result of the experiments at Boston is not only the most valuable testimonial to the father's system of visible speech, but an honour which the inventor of the telephone may well consider as the highest he has attained.

Among all the recent steps in the progress of science, I know none of which the truly scientific or science-producing consequences are likely to be so influential as the rise of a school of physiologists, who investigate the conditions of our sensations by producing on the external senses impressions, the physical conditions of which can be measured with precision, and then recording the verdict of consciousness as to the similarity or difference of the resulting sensations.

Professor Helmholtz, in his recent address as rector of the University of Berlin, lays great stress on that personal interaction between living minds, which I have already spoken of as essential to the life of a university.

No man has done more than Helmholtz to open up paths of communication between isolated departments of human knowledge; and one of these, lying in a more attractive region than that of elementary psychology, might be explored under exceptionally favourable conditions, by some of the

fresh minds now coming up to Cambridge. I mean a combined study of music and acoustics. The special educational value of such a study lies in the fact that it, more than almost anything, involves a continual appeal to what we must observe for ourselves.

These facts are things which must be felt: they cannot be learned from any description of them.

All this has been said more than two hundred years ago by one of our own prophets, William Harvey, of Gonville and Caius College:—"For whosoever they be that read authors, and do not, by the aid of their own senses, abstract true representations of the things themselves (comprehended in the author's expressions), they do not represent true ideas, but deceitful idols and phantasms, by which means they frame to themselves certain shadows and chimeras, and all their theory and contemplation (which they call science) represents nothing but waking men's dreams and sick men's phrensies."

Notes.

We observe with great regret that our contemporary on the other side of the Atlantic has taken in a captious spirit some remarks in an article of ours which was intended to be a tribute of the greatest possible respect to the memory of a man of mark. It is unfortunate that the grace of our desire should have been marred by unasked for and questionable criticism. We do not wish to enter into controversy, but we may say that one fact was one which the person most affected was proud of acknowledging; the other was not only the result of observation, but is vouched for by one most affected, and the third is unfortunately too patent to all the world, principally because it is the daily burden of the American press.

The Telephone.—The "watch" telephone is the newest form of this instrument. It is the size and form of an old-fashioned turnip watch, and can be easily carried in the pocket. The bar magnet is curled round itself, and the coil is fixed to the central pole.

Telephonic communication is rapidly spreading between the American cities. In some parts the charge is only five cents a message, with an extra five cents if it is required to be delivered outside the office.

In a recent number of the American *Polytechnic Review*, Professors Elihu Thomson and E. J. Houston describe a telephone of their invention, named the "Reaction telephone." In form it resembles a Bell telephone, the magnet being a soft iron core, and the coil an induction bobbin with the primary wound on one end or pole of the core. The inner face of the diaphragm carries a spike of carbon, whose point makes contact with a globule of mercury, which is let into a cavity in the end of the iron core. A battery is joined up in circuit with the primary coil, the mercury, and carbon probe, while the secondary coil is connected in circuit with the line. When the diaphragm vibrates under the voice, the probe dips to and fro in the mercury and produces undulations in the primary current, setting up wave currents in the secondary coil, which traverse the line and cause a similar telephone to speak. The electro-magnetic action between the pole of the core and the diaphragm as the primary current varies, gives to this telephone its peculiar name.

Professors Elihu Thomson and E. J. Houston, of Central High School, Philadelphia, write to our contemporary, *Nature*, to say that they have finally solved the important problem of *relaying* telephone sounds. They have effected it by the application of a small Hughes' microphone to the diaphragm of the telephone, the microphone being in circuit with the line over which the sound is required to be relayed. This application was pointed out, as we reported in our last number, by Professor Hughes, at the meeting of the Physical Society on June 17th.

The Microphone.—We understand that Professor Hughes had himself observed the phenomenon first publicly announced by Mr. Blyth, Edinburgh, namely, that the microphone acts as a receiver as well as a transmitter. It appears that Professor Hughes obtained articulation from ordinary microphones before Mr. Blyth obtained it from his cinder-pot, but it was so feeble that he did not publish the fact at once, although he communicated it in a letter to Mr. W. H. Preece. This circumstance should in no way detract from the merit of Mr. Blyth's discovery, and it is probable that the multiplicity of contacts afforded by the mass of cinders increases the power of the sound given out.

Professor Hughes states that any microphone will act as a receiver, and give out sounds if properly adjusted. The microphone which is best as a transmitter will also be best as a receiver, that is to say, the state of adjustment, and the material which transmits sounds most loudly and distinctly will also utter them most loudly and distinctly. Thus pine charcoal gives superior results both as a transmitter and receiver.

The better effect obtained by Mr. Blyth in his experiments with cinders as a microphone (see our last issue, p. 246) on moistening the latter, may be explained on the supposition that the moisture added weight to the cinders, and consequently produced more requisite pressure at the cinder contacts.

The microphone is a striking illustration of the truth that in science any phenomenon whatever may be turned to account. The trouble of one generation of scientists may be turned to the honour and service of the next. Electricians have long had sore reasons for regarding a "bad contact" as an unmitigated nuisance,

the instrument of the Evil One, with no conceivable good in it, and no conceivable purpose except to annoy and tempt them into wickedness and an expression of hearty but ignominious emotion. Professor Hughes, however, has with a wizard's power, transformed this electrician's bane into a professional glory and a public boon. Verily, there is a soul of virtue in things evil.

THE PHONOGRAPH.—In America the phonograph is neither sold nor leased to private individuals yet, but is let out to agents, who pay a royalty of one-fourth the gross receipts for the use of it.

THE moto-phone is the name given by Mr. Edison to a little mechanical curiosity of his in the shape of a motor driven by the voice. The phonographic vibrations of a diaphragm are caused to rotate an axle by means of a stylus and ratchet wheel.

IT IS remarkable that the phonograph foil may be crumpled up in the hand without destroying the reproductive power of the record.

EDISON has perfected a fog-horn that can be heard ten miles, but when it comes to an invention for getting his hired girl up in the morning, he smiles sadly, and falls to musing on the infinite.—*Utica* (*U.S.*) *Observer*.

A LONG-DISTANCE TELEGRAM.—A telegram of thirty-three words was recently sent from Auburn, U.S., to Sydney, Australia, costing 65 dollars. Its course was from Auburn to New York, Heart's Content, Newfoundland, Valencia, London, through Germany, Russia, and Siberia, to Wladiwoodstock, a point on the coast of Manchuria; thence to Nagasaki, Japan; thence through the Yellow Sea to Shanghai, China; thence down the coast of China, by Saigon, Siam, Singapore, and Batavia, to Port Darwin, on the northern coast of Australia; and thence to Sydney, New South Wales.

DURING the afternoon of Sunday, June 23, a thunderstorm of tropical violence raged over London. The lightning was both forked and sheet, the thunder-claps resembled sharp salvoes of artillery, and the rain literally came down in bucketfulls. Many houses, chimneys, and trees were struck by the lightning, and in various parts of the city and suburbs the lower rooms and cellars of streets were flooded by the rain, or the bursting of water-pipes. A sewer gave way at King's Cross, and flooded the Metropolitan Railway line as far as Farringdon Street, so that traffic had to be suspended. At South Hackney the lightning struck the back of a house, breaking the glass, and tearing up the frames of the windows of a room, then passing through the floor to the room beneath. A splinter of wood was flung upon a bed in the apartment where two infants were sleeping, without injuring them. In the Walworth-road district a house in Mann-street was struck, the lower rooms appearing for an instant full of flame; carpets and rugs were set a-fire, the fire-irons twisted and broken, and a lady occupant severely burned on the right hand and arm, her hair being also singed. At Croydon the rain was mingled with large hailstones, some the size of a marble, and in general of a truncated-conical shape. A large elm tree in the neighbourhood was furrowed down its trunk and two main limbs by the track of the discharge, which had burst off the thick outer bark, at places laying bare the wood underneath. The two furrows ran irregularly down the opposite sides of the trunk, and ended at the points where a black tarred paling abutted on the tree, and was nailed to the trunk.

A RUSTIC LIGHTNING ROD.—A French agricultural paper announces the discovery that bundles of straw bound on broom-handles and stuck upright over the roof will effectively protect a house from lightning. The first trials of this apparatus were recently made at Tarbes (Hautes Pyrenées) by some intelligent agriculturists, and the results were so satisfactory that soon afterwards eighteen communes of the Tarbes district decorated their houses with these "stuck-up" but at the same time unostentatious and ingenuous lightning protectors, and it is reported that there have been no accidents from lightning since. By what experimental process the intelligent agriculturists came to their conclusion is not stated; nor can we learn what the idea was which inspired the plan, although it appears to have been the old proverb about a hair of the dog which bit you, for it has long been known that witches ride the storm on broomsticks.

WE learn from the *Operator*, U.S., that it is proposed to form a protective association amongst American telegraphists. The monopoly of the Western Union Company, and the recent unpopular measures of salary gradation in that company, have helped to render such a step prudent on the part of operators. No strike or aggressive policy is at present contemplated, the organization being regarded as a safeguard for the future.

THERE are now 125 telegraph stations in Japan, and over 5,000 miles of wire. More than 1,000 miles of line are in course of construction, and the system will be still further extended. The first practical telegraphic line in Japan was put up at the close of the year 1869, and the advance made since then is highly creditable to Japanese enterprise.

AT the great *fête* to be given by the City of Paris, several of the most popular parts of the city will be illuminated during the whole night by splendid lustres of Jablochkoff electric candles. It is estimated that there will be as many as 200 candles lit.

A CABLE is now being laid between Constantinople and Salonica.

WE are gratified to learn that some £50 have been subscribed for placing a stone over the grave of Alexander Bain. The stone and inscription will be a simple one; but it is right that some such memorial should mark the spot where the great but ill-starred inventor lies. His fame requires no monument. In the French Telegraphic annexe at the Paris Exhibition, there is a kind of electrical trophy in the centre of the hall, inscribed with the names of a few of the most famous electricians; one of the names is "Bain."

THE Singapore Hongkong Cable of the Great Northern Company having been restored, the repairs of this Company's Hongkong Amoy Cable will now be continued. Until the repairs are effected, the Company cannot accept Messages for Hongkong; but meanwhile the Company's lines are the only telegraph route to Amoy (Foochow), Shanghai, and the stations in Japan.

CABLE REPAIRING IN THE WEST INDIES.—The steamship *Professor Morse*, belonging to the International Ocean Telegraphic Company, in command of Captain Thos. Stead, sailed from New York, Thursday May 30th, for Key West, to repair the Company's No. 2 Cable (south) which was reported broken some weeks since, about 27½ miles from Sand Key Light. The expedition is in charge of Mr. George Keith, Manager of the Cuba Submarine Company's Cables at Cienfuegos, who has had considerable experience in grappling for and laying cables in deep water. He will be assisted by the Company's superintendent of cables, Mr. M. L. Nellings, stationed at Key West. Mr. G. B. Prescott, Director of the electrician's office, accompanies the expedition, also Mr. James Orton. It is expected the *Morse* will be absent about a month. —*Journal of the Telegraph*, U.S.

The Virginia, U.S., telegraph line, including the branch from Alexandria to Pursellville, London County, has been purchased by the Western Union Telegraph Company.

MR. TEGG, the well-known publisher, is writing a work on "Posts and Telegraphs, Past and Present," to which will be appended an account of the telephone and phonograph.

A BIOGRAPHY of the late Mr. Alfred Smee, F.R.S., with selections from his writings on scientific and social subjects, is in the press. It is edited by his daughter, Mrs. Odling.

M. EDMOND BECQUEREL has been elected Professor of Applied Physics and Natural History in the room of his late father.

ON July 1st, a publication, entitled *L'electricite*, will appear, for the purpose of promoting the holding of a special electrical exhibition in the Palais de l'Industrie, Paris, in 1879.

DR. ALEXANDER MUIRHEAD, who has recently returned from America, after duplexing the Direct United States Cable, is, we believe, about to start for Madras to duplex the Madras-Penang Cable. Muirhead's duplex system will also be applied shortly to the Malta-Gibraltar cable.

JABLOCHKOFF'S electric candle is rapidly making headway in Paris. Besides the 8 lamps of the Place de l'Opera, and those of the Magasins du Louvre, there are now 24 extending down the fine new Avenue de l'Opera with splendid effect. The place du Théâtre Français, the Palais Bourbon, fronting the Place de la Concorde, the Belle Jardiniere, the Concert de l'Orangerie in the Gardens of the Tuileries, the Arc de Triomphe, and the great Hippodrome at the foot of the Avenue Josephine, are also illuminated by the candle. A powerful lamp is being set up on the pinnacle of the Trocadero Palace.

AN ELECTRICAL GYROSCOPE.—In a recent number of the *Scientific American*, Mr. Geo. M. Hopkins describes an ingenious gyroscope, constructed to rotate continuously by means of electricity. The gyroscope is supported on an upright standard, on which its axis is pivoted horizontally. A double poled electro-magnet is fixed to the back of the gyroscope in such a way as to submit an armature fixed diametrically across the rotating wheel to its attraction, and a contact is arranged so as to break circuit twice every revolution immediately the armature comes opposite the poles of the electro-magnet. In this way the wheel attached to the armature is kept rotating. The wheel, with armature, magnets, and axle, in short the whole gyroscope, is free to be moved in any direction round the point of the upright standard. Two large, or four small, Bunsen cells are sufficient to cause the wheel to revolve with greater velocity, and to make the gyroscope support itself horizontally from the standard in opposition to gravity.

NICKEL PLATING.—M. Kayser in the *Chem. Centr.*, No. 127, 1878, gives the following select conditions for nickel plating. The articles to be plated to be carefully cleaned, and put in a bath composed of one part of the double sulphate of nickel and ammonium to twenty parts of water; the nickel salt to be pure, and also the nickel anode, which should not be smaller than the article to be plated: the current employed to be strong. When the bath gets acid it should be neutralised by the addition of dilute ammonia. In plating copper articles, the bath should contain ammonium chloride, one part to one hundred parts of nickel salt.

ACTION OF LIGHT ON SELENIUM.—M. Forssman, from investigations on the influence of variously coloured lights on selenium, has come to the conclusion that it is not the light vibrations which reduce the

electric resistance of selenium, but vibrations of another order, hitherto unknown, and which have neither a lighting, heating, or chemical effect.

ELECTROLYSIS OF WATER.—M. Bonnet finds that the decomposition of water by the electric current is independent of pressure. His experiments have given results at 154 atmospheres.

INTENSITY OF VOLTAIC POLARISATION.—According to Dr. Fr. Exner the electro-motive force of polarisation produced by currents too feeble to effect a permanent decomposition of water, is constantly and exactly equal to that of the primary current employed.

AT the meeting of the Physical Society reported in the present number, Professor Thomson exhibited by the electric light some beautiful and interesting magnetic figures, illustrating the "lines of force" in electrodynamic relations. The lines were shown by iron filings fixed, as they had arranged themselves, on panes of glass, by means of powdered gum moistened with steam. They were therefore not only beautiful, those of a wire in which a current is flowing resembling ferns, but they were rigidly faithful. The use of diagrams on glass, so common in America, is happily extending here.

ELECTROLYSIS OF CHEMICAL COMPOUNDS.—M. Bleekrode, by help of De la Rue's chloride of silver battery, has recently tested Hittorf's hypothesis that the resistance of a compound to electrolysis depends on the difficulty with which the molecules exchange their constituents, and the results of his investigation in no way support it. He also endeavoured to ascertain whether in a compound the presence of hydrogen, which can be replaced by metals or radicles, is connected with the capacity of the compound for being electrolysed. The substances examined were all in the liquid state, being condensed by pressure when necessary, and not in solution. They were contained in narrow glass tubes, and decomposed by means of platinum electrodes a few millimetres apart. According to Hittorf, those compounds possessing very active chemical properties, or which easily yield hydrogen, should be easily electrolysed.. But water, alcohol, the liquid hydrogen acids, with one exception, are difficult to break up by electrolysis. It should be mentioned, however, that these acids in the pure liquid state are not very active in their chemical properties. The anhydrides of the metals, on the other hand, are both chemically active and conduct electrolytically. The amides, amines, and hydrocarbons showed no correspondence between their chemical properties and conductivity. Nothing definite could be ascertained as to the function of hydrogen, although all the substances either contained hydrogen or a metal. These experiments show ammonia and hydrocyanic acid to be good electrolytic conductors at ordinary temperatures, the only known cases of pure liquids acting in this manner.

ILLUSTRATION OF TERRESTRIAL CURRENTS.—Professor W. Leroy Broun, in *Silliman's American Journal*, gives the following lecture illustration of terrestrial electric currents:—A rectangular frame was made of light poplar laths, in section 3 by 2 centimetres. The length of the frame was a fraction over a metre, its width ¾ of a metre. About the perimeter of this frame were wrapped twenty coils of insulated copper wire; each extremity of the wire was made to terminate near the centre of one of the shorter sides, and passing through the wooden frame was fastened and cut off about 3 centimetres from the frame. This rectangular frame was then so suspended, in a horizontal position, by wires attached to the frame of an ordinary hydrostatic balance, that the longer sides were at right angles with the beam. By adjusting weights in the pans the index of the balance was brought to the zero point. Two small orifices bored in a block of wood, a centimetre apart, served as mercury cups, in which the extremities of the short terminal wires were immersed. Near the bottom and through the walls of these wooden cups were screwed small brass hooks, which served as connections, to which the wires of the battery were attached. The balance was now so placed that the longer sides of the suspended rectangle were at *right angles with the magnetic meridian*, or in the *magnetic* east-and-west line.

When the current from the battery was made to pass around the rectangle from east to west on the northern side, and from west to east on the southern side, by the theory of terrestrial magnetism the northern side of the rectangle would be attracted, and the southern repelled; and that this was so, the corresponding deflection of the balance rendered plainly visible. When the current was reversed the deflection was in the opposite direction. By breaking and closing the circuit at proper intervals to augment the oscillations, the large frame was readily made to oscillate through an arc of five degrees. When the sides of the rectangle were placed north-east and south-west the current produced no sensible effect. A bichromate-of-potash battery of 16 cells, with plates 25 by 6 centimetres surface was used. With a rectangle having a larger number of coils, attached to a very delicate balance, and a steady battery current, the variations in the magnetism of the earth might thus, Professor Broun thinks, be advantageously observed.

ELECTRO-MOTIVE FORCE OF GALLIUM.—According to former experiments of M. Jules Regnault, the different liquid amalgams have different electro-motive qualities, and he has attributed this fact to the different values of their specific heat. Recently, before the Academy of Sciences, Paris, he demonstrated this assumption by means of the metal gallium, which, as is well known, will after fusion remain liquid at ordinary temperature

He made a small pile out of a plate of solid gallium, covered with a sheet of paper impregnated with solution of sulphate of gallium, and overlaid by a drop of liquid gallium. The metals were joined up through a galvanometer, and on completing the circuit a current showed the liquid metal to be attacked, that is to say, the pole of the highest specific heat.

THE question of including Mauritius in the telegraphic system of the world was brought before the Chamber of Commerce of that island at its meeting on the 13th ult. The chamber was of opinion that a cable *via* the West Coast of Africa, as suggested by Mr. Donald Currie, would effectually destroy their hopes of telegraphic communication, and it was considered that the moment had arrived when the Chamber should once again endeavour to obtain from the home authorities that Mauritius should be included in any system of ocean telegraphic communication between the Cape and any other country that may be decided upon. The President stated that Mauritius was the only sugar producing country depending solely upon steam communication. The matter was eventually referred to a special committee on state telegraphs.

A TARGET which by means of electricity shows instantaneously upon another target set up at the firing station the exact spot where a bullet strikes, and thus does away with the necessity of employing a marker to signal the result of each shot, has been recently perfected, after years of labour, by a Swiss locksmith. The exact details of the target in its latest form are not yet published, but a description was given a short time ago in a Swiss paper, and also in an Austrian military periodical, of a target on the same principle, which was successfully tried last year. In this target the face is divided into a number of concentric rings, and each ring again is divided by two lines drawn right across the faces and crossing each other at right angles at the centre. In each of the subdivisions of the target at the firing station a small hole is pierced, and when a bullet strikes the distant target, a number at once appears in the hole in the corresponding subdivision of the target near the shooter; or, should the ball strike upon one of the lines dividing the face of the target, numbers are shown in both the adjacent subdivisions. In the trials made with the target the apparatus worked perfectly during the eight days for which thefir ing was kept up; the only accident which happened being that once the electric wire was cut by a bullet.

"*Un Drame au fond de la Mer*" has been revived at the Theatre Historique, Paris. This play is founded on the novel of Cortambert, and it may be remembered that it involves the sailing of a cable ship and the laying of the cable. It is interesting as being the first attempt to idealize such an enterprise, and we cannot but admire the hardihood of the novelist who has attempted to extract romance out of real cable ship. It is plain, however, on seeing the drama, as presented at the Historique, that the writer was never on board a cable ship in his life. Perhaps it is just as well, for then he might have felt all the romance of it oozing out of his finger tips, and we should have had no drama at all. The time of the cable-laying scene is, we think, happily chosen. It is laid in the dusk, after the sun has set, and the stars have begun to appear. The paying out operations are highly original. The chief electrician takes hold of the cable where it issues from the tank, a small trap door in the stage, and passes it rapidly hand over hand to the cable machine, which resembles nothing so much as a letter press, surmounted by a Watt's governor. The governor revolves rapidly, puffing all the time like a steam engine. More electricians seize the cable, and direct it over the ship's bulwarks into the sea, all working at express speed, and keeping time with the governor, while the captain, the officers of the ship, and the supernumeraries recline or stand by in picturesque groups about the deck. At last comes the catastrophe—the cable parts. There is great uproar and confusion, and rushing to and fro of the captain and his crew, the baffled electricians, and the picturesque supers; but it is all of no avail. The end is overboard and lost in the sea. What can be done? Nothing, except to go overboard after it, and fetch it up again. Accordingly, the chief electrician, a very hard-worked official, and doubtless underpaid withal, dons a diver's dress, and accompanied by his two principal assistants, goes down to the bottom of the sea in search of the missing cable. He finds there a wreck, and this submarine scene, representing his descent through coral grottoes to the floor of the ocean, and the hull of the sunken ship with its motionless corpses, is the one redeeming feature of the drama. Doubtless the spectators who have never seen actual cable operations, or a cable ship, were charmed; but we could not help feeling that, after all, a real cable machine at work paying out ocean main at six knots an hour is a much finer sight than a theatrical one.

INDUCTION MACHINE FOR NICKEL PLATING.—By a simple modification of Siemens' armature, M. Gaiffe obtains sensibly constant induction currents for electroplating. Instead of a cylindrical bobbin turning concentrically within cylindrical notches in the poles of the inductor, M. Gaiffe employs a bobbin of elliptical section turning in elliptical notches. The major axis of the ellipse of the notches is in plan parallel to the arms of the inductor. The major axis of the ellipse of the bobbin is a little shorter than the minor axis of the notches, so that the rotation may go on without friction. By trials a relation can be established between the diameters of the two ellipses such that the changing of polarity, instead of taking place during a brief interval at each half-revolution, is produced gradually during the duration of the half-revolution, and consequently gives rise to a sensibly constant current. M. Gaiffe

does not pretend that a machine of this kind is more economical than one with ring-bobbins, but he holds that it has the advantage of being fitted to receive, whatever its dimensions, helices of wires of all thicknesses, a condition difficult to realise with annular-bobbins; and, consequently, with a given speed of rotation, it may be regulated so as to give the electromotive force required for the work with the least internal resistance.

The funeral of the late Professor Henry was attended by the president and the members of the United States Executive, Congress having adjourned for the day.

Patents.

2193. "Improvements in apparatus for producing Induced current of electricity, such improved apparatus being especially applicable to transmitting signals, and calling the attention of persons using electrical telephones."—A. F. St. George, June 1.

2202. "Telephones."—W. H. Preece, June 1.

2281. "Improved means and apparatus for distributing and regulating electric currents, to work lamps, and other electric apparatus."—Dr. C. W. Siemens, June 7.

2288. "Apparatus for refracting, reinforcing, and modulating sound."—A. C. Engert, June 7.

2385. "Electric telegraphs."—E. A. Cowper, June 15.

2396. "Telephones and apparatus employed in electric circuits."—T. A. Edison, June 15.

2399. "Improvements in and appertaining to the obtaining of light by means of electricity and in apparatus therefor."—W. P. Thompson (communicated by E. Reynier), June 17.

2401. "Apparatus for producing electric light."—C. Dubos, June 17.

2407. "Improvements in the manufacture of articles produced by the electro-deposition of metal, and in apparatus therefor."—W. R. Lake (communicated by J. W. Sufts). Complete. June 17.

2456. "Telephony."—N. J. Haddan (communicated by G. Black and A. M. Rosebrugh), June 20.

2457. "Telephones and telephonic call mechanism."—H. J. Haddan (communicated by A. M. Rosebrugh), June 20.

2467. "Electro-magnetic clocks." — S. Shepherd, June 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

3726. "Duplex telegraphic printing apparatus."—Gerrit Lolkes Jansma Vander Der Ploeg. Dated October 8, 1877. 8d. This consists of a dial manipulator, a relay, and an electro-magnetic type-printing receiver with a double type wheel against which the paper is pressed.

3743. "Magneto-electric machines."—John Henry Johnson (communicated by the Alliance Company). Dated October 9, 1877. 6d. This machine is specially designed for producing electric lights by alternating positive and negative currents. The currents are collected without the use of rubbers, and consequently without the attendant heating due to friction. The frame work of the machine is rectangular, but built in the plan of a St. Andrew's Cross; the inducing horse-shoe magnets, are arranged in sets of four on the plan of a St. Andrew's Cross, and space is left at the centre of the cross between the poles of the magnets for the rotating axle carrying the armature bobbins, to pass. These sets of magnets form, as it were, partitions across the rectangular frame, the armature axle passing through the centre of each. The bobbins are set round the periphery of a wheel carried by the axle. Each armature so built up of bobbins, rotates between two sets of induction magnets, or partitions. In the machine described, there are four sets of inducing partitions with three bobbin armatures between. The whole of the currents are conducted to one ring by wires, and are transmitted through a rod to one of the bearings, where they are collected and distributed by a leading wire to the electric lamp or other receiver.

3750. "Electro-magnet hydraulic engine."—W. R. Lake (a communication from K. C. Atwood, New York). Dated October 9, 1877. 2d. This consists in a means of controlling the water supply of a hydraulic engine, so as to give a reciprocating motion to the piston. (*Not proceeded with.*)

3822. "Electric telephony and telegraphy."—D. D. Redmond. Dated October 16, 1877. 2d. This consists in a telephone in which the receiver is a thermo-pile. The sound waves, by the heat of compression, generate electrical waves, which are received and reconverted into sound waves by an electro-magnetic receiver, or by a second thermo-pile after the manner of Peltier's cross. The face of the pile may be covered with substances increasing the amount of heat for given sound, or the sound wave may be amplified by dancing flames. (*Not proceeded with.*)

3839. "Distributing and increasing with atmospheric electricity currents proceeding from a single source of electricity for supplying several lighting centres."—Paul Jablochkoff. Dated October 17, 1877. 4d. This consists in a means of supplying a number of centres of illumination from a single source, and strengthening the currents by atmospheric electricity — one electrode of the alternating dynamo-machine is connected to one pole of the condensers of large surface, the other pole of the condensers being led to the electric candle or Kaolin wick—the other electrode of the machine being led to the other side of the wick. Various ways of connecting up these condensers in circuit are figured. They act as storages of the current, allowing it to be distributed in different directions. The patent also claims that they develop atmospheric electricity, and accumulate it so that it can be utilized along with the machine electricity, thus giving a more powerful light.

3854. "Expansion and contraction coupling for signal and telegraph wires."—G. Pickersgill. Dated October 18, 1877. 6d. This consists of a metal cylinder or tube, provided with one or more piston rods, on each of which, and within the cylinder, are mounted any required number of rings or discs of vulcanized rubber. The rods, after passing through the covers on each end of the cylinder, are attached to the wires, and this allows the wires to expand and contract while keeping the required lightness.

3861. "Railway brake and signalling apparatus."—H. E. Newton (communicated by F. E. Eames, Watertown, New York, U.S.) Dated October 18, 1877. 1s. This consists of a vacuum brake and alarm, which is sounded when the brakes are applied, and indicates that part of the train to which they are applied.

3906. "Apparatus for indicating defects in roofs, bridges, &c."—F. Barber (communicated by J. Forbes, Dartmouth, Nova Scotia). Dated, Oct. 22, 1877. 2d. This consists in connecting an electric circuit to a structure so that excessive strain on any particular part shall close the circuit and announce the fact. (*Not proceeded with.*)

3981. "Electric magnets and magnetic motor engines."—M. H. Smith. Dated, October 27, 1877. 6d.

This consists in forming electro-magnets of a coil of wire surrounding a soft iron core, and enclosed in a cylinder of soft iron, the whole being set on an iron base-plate. The motor is formed of a circle of such electro-magnets, which, by a suitable make and break arrangement, cause a disc armature, pivoted over them, to "wobble." The disc is tilted and continually attracted round by successive magnets. The wobbling motion is transmuted, by a crank and shaft, into rotary motion.

4036. "Electric apparatus for applying railway brakes."—H. A. DIBBIN. Dated, October 31, 1877. 6d. This consists of an electric means of releasing or actuating brakes at the driver's option, or by the breaking of a coupling, or by an adverse signal. A magneto-electric battery is placed on the locomotive, or tender, and derives its motion from the axle or the steam of the latter. The circuit of the battery can be closed by the engine driver at will. Wires are also led throughout the train, so that a circuit is closed between the locomotive and any van of the train. A sphere or mass of metal is so adjusted in each van with respect to gravity that when any disconnection of the circuit, or cessation of the current liberates the keepers of certain electro-magnets, the sphere falls by its own weight on a suitable lever arrangement which actuates or releases the brakes employed of whatever kind they may be. The fall of the weight also strikes an alarm bell to warn the guard. Provision is also made for an adverse signal on the line, actuating a contact arrangement on the locomotive, and rupturing the circuit, and by this means putting on the brakes, and arresting the train. Voltaic batteries may also be employed.

Proceedings of Societies.

PHYSICAL SOCIETY.—JUNE 22nd, 1878.

Prof. G. C. FOSTER, Vice-President, and afterwards Prof. W. G. ADAMS, President, in the Chair.

THE following candidate was elected a Member of the Society:—Mr. F. W. Grierson.

Prof. W. G. ADAMS exhibited a new form of Polariscope suitable for projecting on to a screen the figures formed by any crystal, and for measuring the angle between the optic axes. Parallel light from the electric lamp, after traversing a Nicol of about 2-inches aperture, is rendered divergent by a set of lenses. The crystal under examination is placed in a recess formed by removing a slice from the middle of a spherical lens, which is capable of motion in any direction about its centre, while any movement in the vertical plane passing through the axis of the instrument can be measured by a scale and Vernier, and if, by such a motion, the point on the screen representing the position of one axis when the two are in the vertical plane, be transferred to that indicating the position initially occupied by the other axis, we have at once a measure of the optic angle of the crystal, for the rotation of two plano-spherical lenses, forming an exact sphere, has no effect on the direction of the beams.

Mr. WALTER BAILY read a paper on the effect of starch, salicene, unannealed glass, &c., on polarized light. In his experiments light was passed through a Nicol's prism, then through a quarter undulation plate, and then through a body having an optical structure symmetrical round an axis in the direction of the ray, such as any of the above-named substances. The axes of the quarter undulation plate being taken as axes of reference, ρ being the angle between the plane of polarization and one of these axes, σ half the difference of retardation at a given point between the part of the light resolved in a plane through the axis of the body and the part resolved perpendicular to that plane, ϕ being the angle between an axis of the quarter undulation plate and the perpendicular on the axis of the body from the given point (which perpendicular is taken as the initial line in the equation to the ellipse defining the light at such point) and $R\ \theta$ being the co-ordinates of this ellipse, the writer finds the equation to the ellipse to be

$$1 + A \operatorname{Cos} 2\theta + B \operatorname{Sin} 2\theta = R^{-2} \left\{ 1 - (A^2 + B^2) \right\}$$

$$\text{where } A = -\operatorname{Cos} 2\rho \operatorname{Cos} 2\phi$$

$$\text{and } B = \operatorname{Sin} 2\rho \operatorname{Sin} 2\sigma + \operatorname{Cos} 2\rho \operatorname{Cos} 2\sigma \operatorname{Sin} 2\phi$$

From this equation, diagrams have been drawn to exhibit the condition of the light at every point for different positions of the polarizer. For the simple case of salicene, or starch, in which the difference of retardation is the same, or nearly so, for all distances from the axis of the body the diagram consists of a ring of ellipses of various eccentricities and inclinations, each ellipse showing the condition of the light along the radius on which it lies. For the general case, in which the difference of retardation is a function of the distance from the axis of the body, the diagram consists of two series of curves, one series being "isomorphal" curves, or curves along which the eccentricity of the ellipse is constant, and the other series being "isoclinal," or curves along which the inclination of the axis major of the ellipse to the perpendicular on the axis of the body is constant. The general equation to the isomorphal lines is $A^2 + B^2 =$ constant, and to the isoclinal lines $\frac{A}{B} =$ constant. These two series of curves completely define the form and position of the ellipse of polarization at every point, and render it easy to determine what appearances will be presented on passing the light through an analyzing prism in any given position. The results obtained were illustrated by some experiments.

Prof. W. C. UNWIN made a communication on the flow from orifices at different temperatures. A paper recently appeared in the *Franklin Journal of Science*, by Mr. Isherwood, giving results of experiments on this subject, and according to him, the volume discharged from a given orifice is increased by about 12 per cent. on raising the temperature from 60° F. to 212°. It is difficult to accept this result, because the friction is known to diminish the discharge by an amount much less than 12 per cent., and no other cause than decrease of friction can be assigned to account for Mr. Isherwood's results. In the author's experiments, the increase of discharge at 190° above that at 60° was only 4 per cent. with conoidal orifices, in the form of the vena contracta; with thin edged orifices, the variation of discharge was still less. He is disposed to think that the great increase of discharge in Mr. Isherwood's experiments was due to diminution of friction in a rather small pipe leading to the orifices, and would not occur with any other arrangement.

Mr. GORHAM then read a paper on "Complementary Colours." He stated that the three primaries are green, red, and blue, that yellow is a binary compound of green and red; and that yellow and blue when mixed, form white. He remarked that after looking at a green disc the eye evokes another colour, but the undulations must be arrested by a gray surface. This was proved by an experiment.

Mr. Gorham next showed how the grays can be formed by cancelling either reflected or transmitted rays of white light. The first of these cases is illustrated by white paper painted over with a wash of Indian ink, and the second by the well known Berlin tiles, in which light and shade are obtained by giving varying thickness to the ware. He showed that this last effect may be imitated by piling strips of paper to varying heights, and he has succeeded in photographing geometrical figures so formed. Lastly, the author explained a method of arresting and showing the complementaries more satisfactorily than he

considers has hitherto been done. Six thicknesses of white paper are gummed together and cut into a ring, a ring of the same size and shape being also cut from a disc of coloured paper, and the white ring is let in to fill its place. On observing such a disc by white transmitted light the complement is seen through the ring.

Prof. S. P. THOMPSON exhibited a series of magnetic figures, illustrating electro-dynamic relations. The lines of magnetic force around a wire, carrying a magnetic current, can be shown by passing a wire through a glass plate, strewing iron filings around, and tapping the plate gently. The filings may be fixed in their places, if the plate has previously been gummed and dried, by softening the gum with steam. Such a prepared plate may be used to project the figures of the magnetic curves in the lantern. Two parallel like currents attract, their curves forming a figure illustrative of the action; or they repel if travelling in opposite directions, the repulsion also being evident from the form of the curves. It was shown by a series of such lantern slides that a very large number of electro-dynamic relations can be illustrated by curves produced in this manner. Figures were thrown upon the screen illustrating the law of oblique currents, the attraction of a magnet into or its repulsion out of a circuit, the deflection of a magnetic needle by a current, and the mutual tendency of a current and magnetic pole to rotate. A very curious figure was produced by a current running through a magnet longitudinally. A transverse section of the lines of force at a pole gave neither the radial lines of the magnet, nor the circular lines of the current, but a series of spirals. It was argued that Faraday's conception of the lines of force tending to shorten themselves supplied the means of interpreting the physical effects indicated by the lines of force in the various figures.

The SECRETARY read a paper by Mr. C. H. Hinton on the co-ordination of space.

An adaptation of the telephone and microphone, for communicating vibrations to the phoneidoscope, by Mr. TISLEY, was then shown. The metal disc carrying the soap film, is fixed just above the telephone plate, and, this being in circuit with a microphone and battery, any vibration imparted to the microphone at once sets the soap film in action, the characteristic figures being at once obtained.

Mr. A. HADDON exhibited a modified form of microphone, which he has arranged with a view to make the same instrument available for receiving sounds of any given intensity. Its main peculiarity consists in having a thin strip of elastic attached to the middle of the pointed graphite. By varying the tension of this elastic, the sensitiveness of the instrument can be accurately regulated.

The meeting of the Society was then adjourned until November.

THE METEOROLOGICAL SOCIETY.

THE closing meeting of this society for the present session was held on Wednesday, the 9th ult., at the Institution of Civil Engineers, 25, Great George Street, Westminster, Mr. C. Greaves, F.G.S., President, in the chair. J. C. Philips, Esq., J.P., and W. S. Rawson, Esq., were ballotted for, and duly elected Fellows of the Society. The following papers were then read:—

"The Climate of Lundy Island," by A. J. Crespe, B.A., F.M.S. Lundy Island from its geographical position might be expected to have a mild damp climate, with cool summers, and warm winters, and a small diurnal range of temperature, and so, no doubt, it has, although certain local circumstances in addition to its peculiar configuration make the climate remarkably inclement, windy, and unpleasant. The island runs nearly due north and south, having an extreme length of four miles, and a breadth of from 200 yards to 1,600 or 1,800; there is a nearly flat tableland, or "top" running due north and south, having an altitude of 450 feet, shelter there is none, every current of wind sweeps the whole tableland. From the edge of the tableland the ground slopes away to the sea; sometimes the descent of the sideland is extremely abrupt, at other spots, more gradual, while the sidelands are deeply cut by caves, precipices, small bays and glens. All around the island the water is deep a few hundred yards off, while the currents are formidable, and tremendous seas break upon the rocks almost every day in the year. The *one* drawback of the place is the wind, so furious and continuous are the blasts, first from one quarter then from another, for days, and even weeks. When gales occur—they generally do so at short intervals—the force of the wind becomes incredible: walls torn down, gates and doors wrenched out of their fastenings, and the few buildings which can be blown down are more or less injured. Fogs are remarkable for their frequency and density, and are nearly always drenching. The rainfall is nearly 50 ins. per annum. February and March are said to be the coldest months, and August the hottest; the mean temperature of the year is about 50° or 51°.

"On the Auroral or Magnetic Cirrus," by the Rev. S. Barber, F.M.S.

"Contributions to the Meteorology of Natal," by Dr. R. J. Mann, F.R.A.S. This paper is a discussion of the observations taken at the Maritzburgh (2095 ft. above sea level) during the six years, 1860-1865; from it we learn that the summer of Natal is a season of copious rain, and the winter a season of relative dryness, also that the former is a time of abundant and frequent cloud, and the latter a time of preponderant sunshine. The summer is consequently cooler in a material degree than it would otherwise be, on account of the frequent prevalence of cloud, and the abundance of the rainfall; and the winter has its temperature materially raised from the constant occurrence of clear skies and bright sunshine. The mean annual rainfall was 31·13 ins., of which amount nearly 28 ins. came down during the six summer months (October to March), and scarcely more than 2 ins. during the four midwinter months (May to August). Thunderstorms are of frequent occurrence, the average exceeding seven per month from October to March. The thermometer rarely rises above 85° in the shade even in the summer months, unless a hot wind is blowing, it then amounts to somewhere between 85° and 97°, according to the strength of the sirocco. The degree of humidity indicated by the dry and wet bulb thermometers, when a hot wind is blowing, varies from 25 to 52 degrees of moisture. The highest temperature recorded during the six years was 97·0°, the lowest 29°, and the mean 63·3°.

Note on "The Mean Relative Humidity at the Royal Observatory, Greenwich," by W. Ellis, F.R.A.S. In this paper the author gives the mean relative humidity in each month of the year at 9 a.m. and 9 p.m., and the mean of the twenty-four hourly values, derived from the photographic records of the dry and wet bulb-thermometers for the twenty years, 1849-1868. The 9 a.m. value is smaller than the mean in summer, and larger in winter, and the 9 p.m. value is larger than the mean throughout the year, but most in summer. The mean monthly values change little from April to August, and from October to February; and there is a great decrease between February and April, and a corresponding great increase between August and October. The mean for the year is 80·7.

"On a method of sometimes determining the amount of the Diurnal Variation of the Barometer on any particular day," by the Hon. R. Abercromby, F.M.S.

"On the relative Duration of Sunshine at the Royal Observatory, Greenwich, and at the Kew Observatory, during the year 1877," by G. M. Whipple, B.Sc., F.R.A.S. The author having instituted a comparison of the amount of sunshine recorded at these two Observatories, finds that the totals show that, for the whole year, the excess in the number of hours the sun shone at Kew over the number at

Greenwich amounted to 171. This difference is, no doubt, due to the direction of the wind, for Greenwich lying to the south-east of the chief part of London, and having also large manufacturing establishments on its northern side, is greatly shaded by cloud—probably in a great measure due to smoke when the wind blows from W.N.W. or N., while at Kew, which is situated to the west of London, and is remote from factories and shipping, enjoys a larger percentage of sunshine with these winds. With winds from the N.E., S., and S.W., Kew has but slight advantage over Greenwich. With E. and S.W. winds, the London smoke is driven over Kew, and its presence in reducing the transparency of the air is evident in the diminished amount of sun recorded—the quantities being only 81 and 65 per cent. of those registered at Greenwich.

"Account of the atmospheric disturbance which took place in lat. 21° N., and long., 25° W., on January 27-28, 1877," by J. H. Carden.

"Notes on some remarkable cloud formations accompanying sudden and frequent changes of temperature and wind," by Capt. W. Watson, F.M.S.

General Science Columns.

CONTINUOUS BRAKES.

PART III.

WESTINGHOUSE AUTOMATIC BRAKE.

THIS brake has, up to the present time, established itself more in favour with the several railway companies than any other of its competitors. It consists first, of a small engine fixed on the locomotive, and deriving its steam direct from the boiler, which works a direct acting pump to force air at pressure into a main reservoir placed underneath the foot-plate of the engine. A line of tubing extends from the main reservoir longitudinally throughout the whole length of the train, with a cock at each end of each carriage, the connections between the carriages being formed of india-rubber hose and metal couplings. Under each vehicle a branch from the main pipe leads through a triple valve to a small supplementary air reservoir, and also to two vertical cylinders provided with pistons fixed under the carriage, and on either side of it, midway between the wheels. To the bottom of each cylinder is hung, by a pair of links, two cast iron cams or quadrants. Each cylinder is provided with a piston, the rod of which passes out through its upper end, and to the top end of this there are attached two links of such form that they pass down the outside of the cylinder. Near their lower ends these links are connected with the cams or quadrants just mentioned, and at their extreme lower ends they are connected with the thrust rods of the cast-iron brake blocks. Thus, when the cylinder piston rises, it draws upwards with it the two links last mentioned, and in doing this the eccentric quadrants roll against each other, forcing the links apart, and, acting on the brake-rods, thrust the brake blocks against the wheels. By the reverse of this action the brakes are made to leave the wheels. The brakes on the engine are similar in principle to the carriage brakes, but the blocks are applied lower down on the wheels, and the arrangement of cylinders and links is somewhat different. Upon a train being made up, compressed air is allowed, by opening a three-way cock on the engine, to flow from the main reservoir and charge the whole of the main pipe, and all the carriage reservoirs, at an uniform pressure, by which action the brakes, which in their normal position are applied to the wheels, are released.

When in actual working it is desired to apply the brakes, the compressed air is allowed to escape from the main pipe into the atmosphere, through the three-way cock above referred to. The reduction of pressure, to a small extent, by this means operates upon a diaphragm in the triple valve under each carriage, instantly closing a port between the carriage reservoirs and the main reservoir, but permitting, at the same time, the air under pressure to pass from the reservoir to the brake cylinders in proportion as the pressure in the main is reduced, and thereby applying the brakes. By restoring pressure from the main reservoir to the main pipes, the triple valves are shifted, so as to charge again the carriage reservoirs, at the same time opening a discharge port in each triple valve by which the air can escape from the brake cylinders, and thus release the brakes. The act of breaking asunder the train at any part has the same effect as allowing the air to escape from the main pipe through the three-way cock on the engine, or through openings provided for the same purpose in the guards' vans or elsewhere. During the experiments undertaken by the royal commission, from whose report the above particulars are taken, the time occupied in applying the brake from the engine to the rear vehicle, was from one and a half to one and three-quarter seconds, whilst the time occupied in taking it off was from three to six seconds; and this brake throughout all the experiments gave the most rapid action, both in putting on and taking off, of any that were tested. The mean retarding force of the Westinghouse Automatic Brake has been shown to be over ten per cent. of the gross load of the train, and the distances within which the trains were brought to a stand, at different speeds, were as follows:—At thirty miles an hour, 282 feet; at forty-five miles an hour, 634 feet; and at sixty miles an hour, 1,128 feet. These results were obtained with the use of sand; without sand the distances were 300, 675, and 1,200 feet respectively. It is unnecessary here to enter into details regarding the numerous accidents which, according to the reports of the Government inspectors, have been avoided altogether, or greatly reduced in their effects by the use of the Westinghouse Automatic Brake, and the general opinion entertained of its efficiency is, perhaps, best expressed by the number of railway companies that have, up to the present time, either wholly or in part adopted it for general use on their lines.

SMITH'S VACUUM BRAKE.

This brake, next after the Westinghouse Automatic, has apparently been more extensively tried than any other of the continuous brakes. Its arrangement is as

follows:—On the side of the smoke-box of the locomotive there are fitted two steam ejectors for exhausting air, which under ordinary circumstances operate conjointly, but are capable of acting independently in case one should get out of order. Under each van and carriage throughout the train there is an india-rubber cylinder, stiffened with internal metal rings, and capable of collapsing and expanding lengthwise, and under the tender there are two such cylinders. These cylinders are in communication with the ejectors on the engine by means of a double line of pipes, connected at the tail of the train, and forming a complete circuit through it, with hose couplings between the carriages. On steam being admitted to the ejectors by the driver, the air is exhausted from the collapsing cylinders, and the moveable end of each being connected with the ordinary brake gear of each carriage, the brakes are at once applied. By opening an air-valve the cylinders refill, and the brakes are released. In addition to the above, there may also be applied in the front and rear guards' van another arrangement for applying the brakes in case of emergency. This consists of an air-exhauster in each van, nearly over one of the axles. On this axle a grooved friction-wheel is bolted and keyed, and in line with this another grooved friction-wheel is suspended from the carriage in such a way that it can be thrown into gear with the first wheel, or kept clear, at pleasure. By means of a belt passing up through the floor of the van, the second wheel, when set in motion, drives the wheel of a rotary pump-exhauster fixed in the van. Near the pump in the van is a lever held up by a notch in a standard, and when the pump is required to work the lever is pushed out of the notch by a cam lever, by which operation the second friction-wheel under the carriage is thrown into gear with the axle-wheel, and, if the train is in motion, the pump is set to work, and the air exhausted from the collapsing cylinders under the carriages. By means of a cord attached to the cam lever in the van, and running the whole length of the train and on to the engine, the driver, or any guard or passenger in the train, has the power of starting the exhauster. In addition to this there may also be a cord connected with the collapsing cylinders under the carriage, by which any movement in them may be made to sound gong bells in the guards' vans, and close to the driver on the engine. Also by the act of the driver exhausting the air from the collapsing cylinders, by means of the ejectors, the pump exhausters in the vans are started. The action of this brake is slower than that of the Westinghouse, and in the experiments undertaken for the Royal Commission it was found that the time occupied in applying it from the engine to the rear vehicle was from $4\frac{1}{2}$ to 5 seconds, whilst to take it off required about $24\frac{1}{2}$ seconds. The mean retarding force of Smith's Vacuum Brake was shown to be 7·47 per cent. of the gross load when sand was used, and only 5·72 per cent. without it. Under these circumstances it can be no matter of surprise to find that the power of the brake in bringing a train to a stand within a certain distance is considerably inferior to that of the Westinghouse Brake; with sand, the train running 30 miles an hour was brought up in 403 feet, at 45 miles, in 907 feet, and at 60 miles in 1,612 feet, whilst without sand the distances were 525, 1,181, and 2,100 feet respectively.

(To be continued.)

ALLOTROPIC METALS.—M. M. P. Schutzenberger in continuing his researches on the deposition of metals by electrolysis now finds that other metals, and notably lead, assume an allotropic form as well as copper. When the current from a Bunsen element is passed through a solution of 10 parts of caustic potash in 100 of water, with a plate of lead for the positive electrode and a plate of copper or well-polished gold for the negative, the two plates being parallel and at a distance of from 3 to 4 centimetres, a burnished bluish white metallic coating may be seen to form on the negative plate. If at this moment the plate be withdrawn from the bath and exposed to the air after having been washed in luke-warm water which has been boiled, the coating quickly disappears, allowing the yellow colour of the underlying metal to show itself. It seems as if the metal had evaporated, but it really forms itself into oxide of lead, which no longer conceals by a thin covering the colour of the copper or gold. During the electrolysis hydrogen is given off at the negative pole, so that the proportion of lead removed from the positive plate is greater than that which is deposited on the negative electrode. When the dose of dissolved lead ceases to be very feeble, the metal which deposits itself, instead of forming a polished coating, takes the appearance of a voluminous gray sponge bearded by feathery masses. This sponge well-washed with boiled water, and dried in a vacuum, leaves a lead powder which transforms itself in less than an hour, by contact with the air at ordinary temperatures, into yellow crystalline oxide, having the aspect of talc. When on the development of this sponge, which is extremely voluminous, the distance between the two electrodes is notably reduced, or when the bath becomes too highly charged with the dissolved metal, the deposit suddenly changes and takes the well known appearance of the "tree of Saturn" (brilliant plates).

Allotropic copper, reduced to powder under water and washed, always retains some acetate interposed as well as oxide. The purest specimens, dried in a vacuum, disengage when warmed in an inert gas at 450° C., from $\frac{5}{10}$ to $\frac{2}{10}$ per cent. of condensable vapours in great part formed of acetic acid; the residue loses by hydrogen about 1 per cent. of its weight of oxygen. It is therefore impossible to decide by a direct experiment, whether the allotropic copper does or does not contain occluded hydrogen or non-eliminable at 100° C. In every case the proportion of this hydrogen does not surpass $\frac{2}{100}$ per cent., and it is hard to attribute to that proportion a marked influence over the properties of the metal.

The following experiment solves the question in favour of an allotropic modification of copper. A fresh plate which only disengaged nitric protoxide mixed with nitrogen, under the influence of dilute nitric acid (10 parts acid to 100 of water), was heated for 24 hours to a temperature of 100° C., in water slightly acidulated with acetic acid in a sealed tube. After cooling no increase of pressure was proved, the copper treated by the dilute nitric acid furnished nitric bioxide mixed with 10 per cent. at most of protoxides.

With water alone, the transformation affected itself equally, but was more or less slow or incomplete. After 24 hours' heating to 100° C., the copper gave $\frac{2}{3}$ of bioxide and $\frac{1}{3}$ of protoxide; when heated to 150° C., after 24 hours, it gave $\frac{3}{4}$ bioxide and $\frac{1}{4}$ protoxide. It is probable that a state of equilibrium is set up for each condition between the two kinds of copper as in transformations in general.

Suboxide of copper treated cold, in a fine powder, by nitric acid (at 10 parts for 100) behaves like a mixture of copper and bioxide, $Cu^2O = Cu + CuO$. It dissolves from the copper nitrate without disengaging any gas, and remains a finely divided copper which is not attacked by dilute nitric acid at ordinary temperature, and offers in consequence properties directly the inverse of those of the copper produced by electrolysis of the acetate.

CORRUGATED INDIA RUBBER has been applied to the tread of railway carriage steps in America, with a view of preventing slipping of the feet, even in wet weather.

VEGETABLE IVORY, as it is called, by M. Turpin, its inventor, is formed by mixing calcined magnesia with a solution of caoutchouc, and compressing the mixture in a casting mould, properly heated. It is simply caoutchouc hardened by admixture with magnesia. It is beautifully white, like ivory, and can be carved, tinted, and polished like it. Should its insulating properties admit, it may be useful to makers of telegraph apparatus.

NIGHT SIGNALS.—Lieutenant Very, of the U.S.N., has devised a pistol for firing coloured stars to a height of 60 or 80 metres in the air. They are bright enough to be seen at 10 or 12 miles. The two colours, red and green, by their combinations, are made to indicate the numbers from 1 to 10, and hence to signal all the articles of maritime tactics.

THE TALKING MACHINE OF PROFESSOR FABER, OF VIENNA.—Faber worked at the source of articulate sounds, and built up an artificial organ of speech, whose parts, as nearly as possible, perform the same function as corresponding organs in our vocal apparatus. A vibrating ivory reed, of variable pitch, forms its vocal chords. There is an oral cavity, whose size and shape can be rapidly changed by depressing the keys on a key-board. A rubber tongue and lips make the consonants; a little windmill turning in its throat rolls the letter *r*, and a tube is attached to its nose when it speaks French. This is the anatomy of this really wonderful piece of mechanism.—*Nature.*

SAILING CARS, driven by the wind, are now in use on the railway tracks which run over the long level prairies of Kansas, and other Western American States An average speed of thirty miles an hour is obtained on some of these.

METEORITES.—An examination of the meteoric fragments which recently fell at Santa Caterina in Brazil shows that there are two distinct types of meteoric iron—one characterised by the presence of a notable quantity of millerite, or sulphate of nickel, mixed with pyrrhottin—whilst the other contains pyrrhottin only, The iron is in the form of a metallic breccia, cemented by the sulphate. The first type contains hardly any carbon, while the second contains a considerable proportion.

THE ETHER.—According to the hypotheses put forward by M. Favé, at the French Academy of Sciences, the molecules of ponderable matter are constantly executing short and rapid vibrations, which set up wave motions in the ether. The length of the ether waves is proportional to the period of the vibrations. They are all propagated uniformly at the same speed, whatever be their length. The ether waves infringing on bodies whose molecules vibrate in the same period intensify the vibrations of the latter. They cross each other in space, each particle of the ether moving in the direction of the resultant of the forces to which it is subjected. Thermal, luminous, or chemical effects are produced according to the length and amplitude of the wave, and the vibratory system of bodies on which they impinge.

Correspondence.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

WE have much pleasure in publishing the subjoined letter:—

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—My attention has been drawn to a paragraph in the *Telegraphic Journal* of the 15th ult., which infers that undue delay has taken place in declaring the dividend (payable 24th inst.) for the quarter ended 31st March last. I beg to inform you that the delay is consequent upon the time needed to remit this company's receipts from Brazil, and for the maturing of the bills which are payable ninety days after sight in London. The receipts for messages to South America are also subject to some delay.

I am, Sir,
Yours truly,
THOMAS FULLER,
Managing Director.

THE TELEGRAPHIC JOURNAL.
VOL. VI.—NO. 131.

THE CAPE CABLE.

THE question of telegraphic communication between England and the Cape of Good Hope seems now to be taken up in earnest by the Imperial Government, and by the Colonies concerned. It is even reported that arrangements are being made for extending the system of land lines in the Orange Free State, so as to meet the coast at the point where the South African Cable will ultimately be landed. We are glad to hear of this revival of activity in submarine cable laying, and hope soon to hear of the arrangements for the projected scheme being complete, and the work proceeding.

The proposal for a cable to the Cape was first seriously entertained in 1873, when agents of three different telegraph companies were sent out to discuss the matter with the local Cape governments. The result was a contract with Messrs. Hooper and Co. to complete a cable from Aden to the Cape by December 31st, 1875. Early in 1875, however, Messrs. Hooper, who had begun the manufacture of the cable, requested more favourable terms, and the former contract became nullified altogether. Last year the subject was again mooted by Mr. John Pender, who advocated a cable from Aden to Natal, with a branch to Mauritius, while Mr. Donald Currie supported the general object, but favoured a west coast route, *via* the Island of St. Vincent. It is well understood that an east coast cable would be advantageous to the Eastern Telegraph Company, with which Mr. Pender is connected, and that a west coast cable would, to some extent, benefit the shipping interest associated with Mr. Currie, and therefore their advocacy of these opposite rôutes is natural enough. But, of course, these gentlemen were wise enough to know that the question of routes must eventually be decided in the interests of the Colonies themselves. Everything considered, we think that Mr. Pender's route is the most advantageous to the latter, and fortunately, if adopted, it will also prove advantageous to existing telegraph systems.

Mr. Pender's modified scheme is to connect Aden to Zanzibar, Mozambique, and Natal, by cables, and Natal to Cape Town by land-lines. To effect this, some 4,000 miles of cable will be required. The lowest price at which the Telegraphic Construction and Maintenance Company can make and lay this length within nine months after date of contract is stated by him to be £900,000, or at the rate of £225 per mile. The cost of a repairing ship and her equipment would add to this sum another £50,000, making a first outlay of £950,000 in all. This amount would be raised by the Imperial Government at an annual interest of, say £33,000. The Eastern Company are, we understand, prepared to work the line for £7,000 yearly, and to allow a rebate of 15 per cent. from their ordinary tariff for all messages sent over their system, a concession which would amount annually to about £13,000. To the interest on cost of construction, £33,000, plus this £7,000 for working expenses, must be added £10,000 for the maintenance of a repairing ship, and £19,000 for the formation of a sinking fund to renew the cable on an average every 20 years, making a yearly total of £69,000. From this amount will have to be deducted the annual receipts of the line, which Mr. Pender estimates at £33,000 at a tariff of 5s. per word from South Africa to Aden, and the £13,000 for rebate, leaving a balance of £23,000 to be made up by subsidies from the Cape Colonies, the Sultan of Zanzibar, and the Portuguese Government, who have offered £2,500 a year if the cable be landed at Delagoa Bay, and £5,000 a year if it be also landed at Mozambique.

If it is decided to carry out the branch to Mauritius (and the colonists there appear to be anxious to have it), an additional 1,500 or 1,600 miles of cable will be necessary. In this case the total capital required will be over £1,300,000. The interest and other expenses will be increased accordingly, but it may be shewn that the total deficit will exceed the deficit in the former case only by two or three thousand pounds, which can be raised by subsidy from Mauritius.

After the Cape cable *via* Aden with a branch to Mauritius is working successfully, we shall doubtless soon hear of another scheme to connect Mauritius with Ceylon.

"EDISON'S THUNDER STOLEN."

WE are glad to see that the discovery of the microphone by Prof. Hughes is beginning to be regarded in its proper light by the scientific journals of America, and as these are the only journals competent to consider the matter, and the only ones which should have been allowed to do so, all the deluge of newspaper articles which have been written on the subject may be ignored as so much waste paper. The European mail, which brought a full account of Mr. Preece's lecture before the Society of Telegraph Engineers, has enabled American scientists to understand the real nature of the microphone, and to discern the distinction between it and the Edison Carbon Telephone. Mr.

Edison, however, continues his rash and reckless assertions in the public press. "Edison's Thunder Stolen!" is the "violent" heading of a long article in the *New York Sun* of June 9, relating an interview with the inventor immediately on receipt of the mails with Mr. Preece's lecture.

We have tried to discover the connection between the heading of this article and the subject in question, but without avail, unless, indeed, we are to suppose that Mr. Edison has a proprietary right in the fires of heaven, having taken over the business of Jupiter. The carbon telephone, on this supposition, might appropriately be regarded as one of the thunderbolts of the effete god. If this be so, woe to the luckless inventor who shall wittingly or unwittingly trespass on Mr. Edison's triple-guarded patents. If any man should by any possibility re-discover symptoms of that marvellous "Etheric Force" which has so mysteriously disappeared from creation, Mr. Edison will summon around him the minions of the Press, and startle the world with the terrible announcement that Edison's Cosmos is Plundered!

In the article in the *New York Sun*, we are told that a "*Sun* reporter showed Mr. Edison the accounts in the London papers quoted above, and asked, 'What do you say to that?'

"The inventor stood in the doorway of his laboratory, dressed in his working costume, and wearing his historic slouched hat. His hands were still grimy from contact with the tools and machinery of the workshop. He glanced rapidly over the articles. His first exclamation was;

"'Phew!'

"Then he read a little further, and ejaculated:

"'Well!'

"At length, as he finished the perusal, he said, with his most comical of expressions, and with a twinkle of humour in his eyes: 'I declare that is the coolest, cleanest steal that I ever knew.'" We refrain from repeating the rest.

Mr. Edison then proceeded to support his case by a course of argument, backed by quotations, which appears to us to be speciously misleading.

It is not our intention to follow him all through it, but we give the following sample of his method:

"Did you show him (Mr. Preece) the microphone," asked the reporter.

"Why, of course I did, because the microphone is contained in the telephone. To say that the microphone is a superior invention to the telephone is absurd, because it is only a part of the telephone. There would be no use in adjusting a telephone to such a delicate pitch, because the jar of a building, the hum and roar of the city, would keep up a continual buz. Hence it could not be a practical articulating telephone." This extract speaks sufficiently well for itself. Mr. Edison did not invent the microphone because he considered it a nuisance!

"The hour for the reporter to leave came all too soon," continues the article, "and as he went from the laboratory he heard Mr. Edison saying to his associate, Mr. Batchelor, 'Let 'em (the English) steal the microphone if they will; that is only a little thing. Before another two years go by, I'll give 'em phones and graphs enough to make 'em sick.'" To make the whole British nation sick! That would indeed be a pull upon John Bull which would convulse Jonathan with delight. And Mr. Edison, if he can do this, if he can make the whole British nation sick, will earn for himself a fame far beyond that of Washington or Columbus, a fame which will be sung by Yankee poets, and spouted by phonographs and strong minded females till the end of time.

We never read these personal articles on the microphone in American newspapers without a feeling akin to disgust which we cannot repress—a feeling which is only tempered by pity for the poor reporters, who have to attend upon a piqued inventor and make a note of the condition of his "historic hat," or chronicle his interesting "Phew." We protest in the name of science and good taste against the majority of these articles. If Mr. Edison thinks he is establishing his claim to the invention of the microphone by charging the newspapers with rubbish he is egregiously mistaken. We regret to say it, but it is too true, that he is only thereby tarnishing his own splendid reputation, and making a laughing stock of himself. In the fevered atmosphere of American journalism such a procedure may pass unchallenged; but in Europe it is regarded with decided disapproval. We hope that Mr. Edison in future will be truer to himself, and that he will continue to astonish his age, rather by the fruits of his mechanical genius, than by his dealings with the newspaper press. For what are great achievements if they do not win respect?

CORDEAUX'S PATENT IMPROVED METHOD OF FIXING INSULATORS.

IN the ordinary method of fixing telegraphic insulators, the bolt by which the insulator is supported from the arm of the telegraph pole is usually connected with the insulator by one end being inserted and cemented in a hole in the interior of the insulator, the other end of the bolt being fixed in the arm by the screwed end of the bolt being passed through a hole in it, and secured by a screw nut. This method of fixing renders the removal of the insulator for cleaning, repair, or replacement very troublesome. The screw nut has to be unscrewed and the insulator as well as the bolt removed from

the arm whenever a new insulator is required. The rusting of the screw nut and screw sometimes renders the unscrewing of the nut very difficult.

This difficulty of removing the insulators has been attempted to be overcome by more than one inventor. The most apparently obvious method is to make the porcelain portion of the insulator to screw direct on to the bolt; this method, however, is not by any means one which could be practically successful. It is absolutely necessary that the porcelain cup be firmly screwed to the bolt, and the consequence is that the expansion of the iron is certain to split the porcelain. Another method which has been suggested is to cement an iron cup into the porcelain and to screw the bolt into the former, the difficulty first pointed out, however, with reference to the bolt and nut, viz., the rusting of the two portions of the iron together, would apply equally to such a method. It has been found, indeed, that an attempt to unscrew an insulator mounted in this manner has resulted in the porcelain being wrenched out of the iron cup secured to it; the adhesion, screw thread of a size and form proper to engage with the concave or hollow screw or screwed hole in the insulator is cut. The screwed end of the bolt is separated from the plain part of the bolt by a flange or collar or shoulder. In fixing the insulator, a ring or washer of cork, india-rubber, leather, or other yielding substance is placed on the screwed end of the bolt; the insulator is screwed on the screwed end of the bolt, the washer being compressed between the insulator and the shoulder on the bolt when the insulator is screwed home, the washer by its elasticity holding the insulator tightly on the screw and preventing its removal by vibration or other accidental cause.

When it is wished to remove the insulator for any purpose, its removal may be effected by giving it an unscrewing motion when it separates from the bolt, leaving the bolt attached to the arm of the telegraph pole.

Fig. 1 represents in elevation and fig. 2 in vertical section, an insulator fixed to its supporting bolt according to Mr. Cordeaux's method.

Fig. 1.

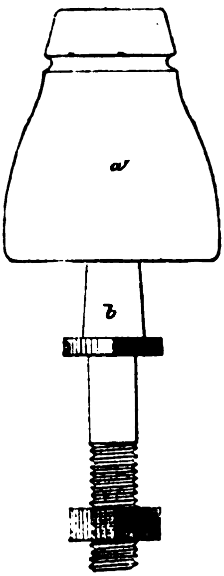


Fig. 2.

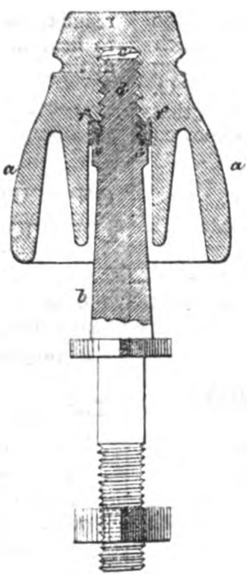


Fig. 3.

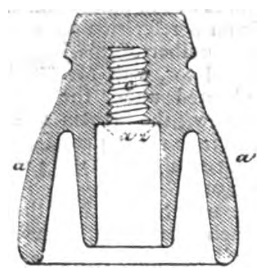
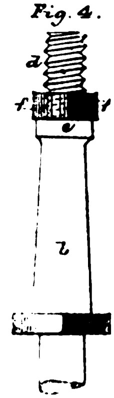


Fig. 4.



through rust, between the bolt and the cup being greater than that between the cup and the porcelain to which it is cemented.

Mr. Cordeaux, of the Postal Telegraph Department, has had these and other difficulties in view, and has devised a method of fixing the porcelain cup to the iron bolt, which is as efficient as it is simple. The method he adopts is as follows:—

A screwed hole is formed in the insulator in place of the plain or unscrewed hole ordinarily made. On that end of the bolt which enters the insulator a

Fig. 3 represents in section the insulator separately, and fig. 4 in elevation the upper part of the supporting bolt separately.

a is the porcelain portion of the insulator; *b* is the bolt by which the insulator is supported, and which is connected to the arm of the telegraph pole in the ordinary manner. In the axis of the insulator and near its head a screwed hole *c* is made, and on the upper end of the bolt *b* is a screw thread *d* of a size and form proper to engage with the concave or hollow screw thread of the screwed

hole *c* in the insulator *a*. Between the screwed end *d* of the bolt *b* and the plain part of the said bolt is a flange collar or shoulder *e*, and supported on the said flange collar or shoulder *e* is a ring or washer *f* of india-rubber surrounding the lower screwed part *d* of the bolt in the manner represented in figs. 2 and 4.

In fixing the insulator *a*, the ring or washer *f* is first placed on the flange *e*, as represented in fig. 4, and the insulator *a* is then screwed on the screwed end *d* of the bolt *b* in the manner represented in figs. 1 and 2. On screwing home the insulator *a* the ring *a* or washer *f* is compressed between the internal shoulder a^2 of the insulator *a* and the shoulder *e* on the bolt, as seen in fig. 2, the washer *f* by its elasticity holding the insulator *a* tightly on the screw *d* and preventing the removal of the insulator by vibration or other accidental cause.

A remarkable feature in this method of fixing is the very high insulating property it gives to the insulator, due, no doubt, to the use of the india rubber washer, and also to the fact that the screwed portion of the iron bolt is not in close contact with the mass of the porcelain of the cup.

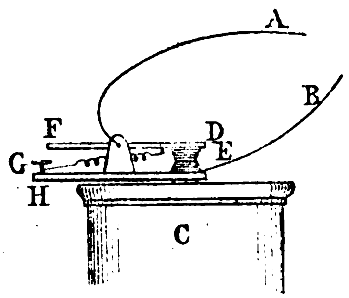
From a reference to a table given on page 190 of the number of this *Journal* for May 1st, in which the insulator, with Mr. Cordeaux's method of fixing is indicated under the name "Porcelain D.S.P.O. large new," the first on the list, it will be seen that the average resistance of a number of tests showed a result as high as 13,374 megohms per mile of 23 insulators.

We understand that the Postal Telegraph department is largely adopting Mr. Cordeaux's method of fixing.

Messrs. Jobson Bros., Phœnix Works, Dudley, are the manufacturers of the insulators.

HUGHES' RECEIVING MICROPHONE.

WE announced in our last issue that Professor Hughes had discovered that any microphone, properly adjusted for speaking, will also act as a receiver, giving forth or uttering the sounds which are communicated to another microphone in circuit, and that the best transmitting microphones were also, as might be expected, the best receiving microphones. He has now designed a special form of microphone for receiving, which gives somewhat louder results than the ordinary "pencil" microphone. The figure represents this special microphone. It consists of a pair of microphonic contacts, made of little studs of pine charcoal, D, E, which are pressed together by means of the pivoted brass lever, F, and the adjustable spring and screw, G. When the spring is tightened, by screwing up the screw G, the pressure of the upper contact D on the lower is increased, and when the spring is slackened, it is decreased. Thus a pressure which gives the best results can be obtained by trial. The base of the contrivance is of light, sonorous, pine wood, and is attached to the top of a drum-head, or resonating box, made of a tin cylinder, C, closed at the upper end by stretched parchment. The wires, A, B, are for connecting this receiving microphone in circuit with the transmitting microphone, which may be of the ordinary "pencil" shape. Professor Hughes employs a battery of six Daniell cells, and, by the help of the resonating drum, is enabled to hear the ticking of a watch and other sounds very distinctly. Speaking heard by this arrangement resembles that



from an imperfectly adjusted Bell telephone, and is hardly so loud; but, for the first of its kind, the results are very striking; and we may expect soon to hear of receiving microphones giving loud and distinct utterance.

ON NEUTRALIZING THE EFFECTS OF INDUCTION BETWEEN TELEGRAPH LINES.

By CHARLES H. WILSON.

[Read before the American Electrical Society, Chicago, December 12, 1877.]

THE interference between well insulated telegraph wires, now universally known as induction, first manifested itself as a disturbing element, in this country, between wires extending from Omaha to Salt Lake, some few years ago. As some serious trouble had been experienced in working two or more parallel wires in that vicinity, Mr. C. H. Summers, electrician, made some experiments, and reported the interference to be "current induction." It did not manifest itself to any noticeable extent upon wires further east, until the duplex system was introduced, at which time it became apparent, probably on account of the large batteries used.

Since the introduction of the various methods of multiple transmission, the effects of induction have gradually become better known, so that it is now regarded by all who have had experience in working the quadruplex, duplex, and other late improved telegraphic apparatus, to be of no little importance. The possibility of removing this difficulty suggested itself to me about one year ago, at which time some complaints were made of difficulties in operating several Morse wires between Omaha and Sioux City. The ideas were carried out experimentally with good success; but, as it was possible to operate the above-named wires by having a "margin" over the induction currents, the arrange-

ment suggested was not practically introduced. The point in view was to devise a means by which electrical currents, similar to the induced currents, could be established in the same conductor, but made to flow in reverse directions, so that one current would be entirely neutralized by the other.

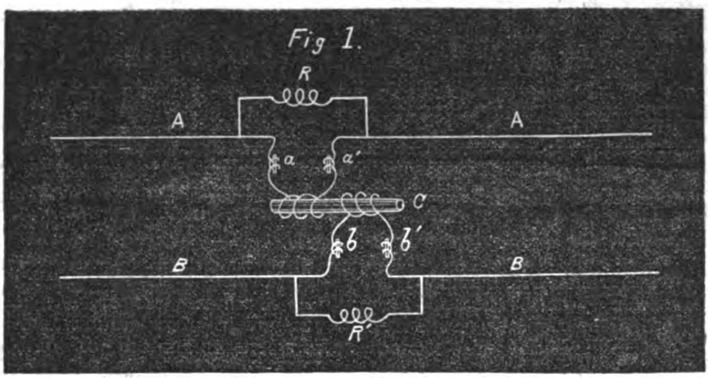
This was accomplished, so far as Morse lines were concerned, by various arrangements of condensers and induction coils. The best results, however, were obtained by the use of the induction coils.

The coils were of No. 30 silk-insulated copper wire, about 300 ohms in resistance, the primary connected in the circuit of one line, the secondary in that of the other. The primary and secondary coils were exactly alike, and were so wound that the battery-currents of the respective lines would pass around the soft iron core in opposite directions when sent from the same end of the lines. It is obvious, from the arrangement of the constituent coils, that the induced currents of the *coil* will flow to line in a direction reverse to the *line-induction currents.*

R and R′ shunt the entire combination on either side. These shunts facilitate the essential adjustment of the equating currents, and also lessen the effect of retardation, caused by the helices, to the battery-currents.

Suppose the line A to have a battery at each terminal in the usual manner. On closing the circuit, two induced currents will be generated, flowing in opposite directions; one in the line B, directly; the other, by means of the induction coil C. These will neutralize and obviate the difficulty occasioned by the induction currents from the line.

Arrangements very similar to the above were tested experimentally on wires between Chicago, Buffalo and Pittsburgh, with the hope of removing an interference which disabled the wires to so great an extent that it was regarded as almost impossible to work two of them quadruplexed at the same time. With slight modifications of this arrangement, the inductive disturbance was dissipated, but the reaction of the helices caused by the extra current, interfered somewhat with the transmission of the signals. It



It was at once observed that having the two currents equal in strength was not the only essential condition requiring consideration. The *time* of the establishment of the two currents must be exactly the same in any section of the line where the neutralization is to be effected; otherwise, two currents, opposite in their direction, would be substituted for the single induction current, and they probably would not materially lessen the difficulty. After trying various devices to meet this condition of *time*, the most successful results were obtained by an application of electro-magnets. The artificially induced currents were made to flow through the coils of a series of electro-magnets, which, by their reaction, prolonged the duration of these currents, and, by means of a rheostat, which formed a shunt around them, the proper adjustment was obtained. By increasing or diminishing the amount of resistance in the shunt, the prolonging effects of the electro-magnets can be adjusted at pleasure.

The application of this arrangement to "Morse lines" is shown in fig. 1: C represents an induction coil, constructed with two well insulated copper wires, with an adjustable core of soft iron; *a*, *a′*, *b* and *b′* are electro-magnets placed in the path of the induced currents generated in the coil C, their function being to regulate the *time* of the neutralization of the two induction currents. The rheostats

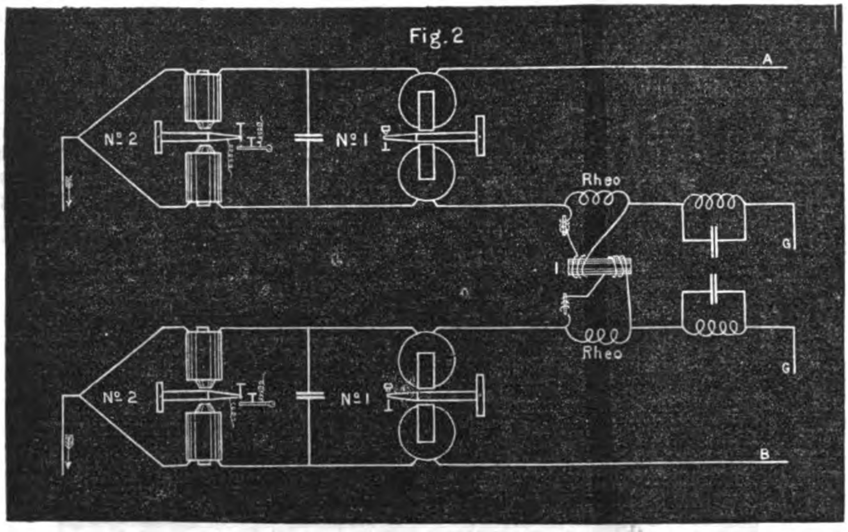
is well known that when an electro-magnet of any considerable size is inserted in a line being worked quadruplex, serious difficulty is experienced in working through it.

In the quadruplex system at present used by the Western Union Telegraph Company, the condition of reversing the poles of the entire battery constantly occurs, and at each reversal there is an instant of no magnetism in the relays at the distant end of the line; and, as a consequence, the armature of the No. 2 relay has a tendency to yield to the force of the springs used to adjust over the "small end" of the battery. When the helices are placed in the line, this neutral space becomes more apparent, and on long lines would cause an interference of signals being transmitted in the same direction. The effects of retardation to reversals were less when the helices were placed in the artificial line, than when in the actual line. This arrangement is clearly shown in Fig. 2.

It is evident that, with the "bridge" or differential principles, all that is required to affect the end in view is to cause the two artificial lines to act upon each other in a manner similar to the action of the actual lines. In the diagram, an induction coil is shown as a part of the artificial lines of the respective quadruplex arrangements, the two wires being well insulated, and wound side by side. The

arrangement approximates sufficiently to the condition of induction between the lines when properly adjusted, which is done in the same manner as in the first arrangement, the same combination of rheostats and electro-magnets being used.

A combination with condensers substituted for the induction coils, is at present used on two wires, one from Chicago to Buffalo, and the other short duration will flow back through the relays of B, and, according to well-established electrical laws, will be in the reverse direction to the inducing current, and another current of short duration will flow in the *same* direction as the inducing current when the battery is withdrawn. At the moment the induced current enters the relays, similar currents, originating in the condensers, also flow



from Chicago to Pittsburgh. The neutralizing effect of the condensers is very much the same as that of the induction coil, and, on account of the former being more readily adjustable, they have up to the present time been preferred. The former is a new, No. 5 gauge, erected last summer (1877), over the P., Ft. W. & C. R.R., from Chicago to Crestline, Ohio, thence to Cleveland, *via* C., C., C. & I. and L. S. & M. S. to Buffalo. The inductive interference being so great between wires extending from Chicago to Buffalo on the same line of poles as to practically nullify the working of two quadruplex circuits. From Chicago to Crestline, a distance of 279 miles, it is parallel to and within thirteen inches of a No. 6 galvanized wire, extending from Chicago to Pittsburgh. This is the only quadruplex circuit in the vicinity of the new wire.

The induction between these wires at once became apparent to such a degree as to prevent the successful operation of both quadruplexes at the same time. The arrangement shown in Fig. 3 entirely obviates this difficulty, and the simultaneous operation of the two wires has been perfectly successful since its application. Its action is as follows:

If the inductive effects of the two wires are equal, the condenser E is alone necessary to effect the neutralization; but when the two wires are entirely dissimilar, the two diagonal condensers F and G are required in connection with E. If a + current enters line A at *a*, it will divide into two parts, one part passing to the line, and the other to the earth by way of the artificial line. When the line current reaches that section of the conductor which is in proximity to B, a current of comparatively back through the other coil of the same instruments, but produce an opposite effect, on account of the differential arrangement of the coils, and, consequently, the magnetic effect of the induction currents is practically rendered null. Each time a current sent into A is *increased*, *withdrawn*, *diminished* or *reversed*, the electrical condition of the condensers between the artifical lines undergoes the same change, and causes thereby a difference in potential on the condenser-plates in connection with line B, the resultant of which is a series of momentary electrical currents between the condensers and the earth. A portion of these currents flows through the relays, there meeting and neutralizing the effects of the line induction currents; *f* and *g* are electro-magnets and resistance coils used to regulate the *time* and adjust the discharge of the condensers so as to exactly equate the line currents.

When a dissimilarity exists in the induction currents of the two lines, the proper adjustment of condensers for one line may not suffice for the other; the two condensers G and F are then used in combination with E. Should A be of a larger gauge of wire than B, or its conductivity be superior from any other cause, it is evident that more artificial line induction will be required to compensate for the influence of B than that of A. When this dissimilarity arises, it is clearly seen that it can be compensated for by properly adjusting G and F. By reference to the drawing, it is clear that the discharge of G will only affect the relays of line B, and that of F will only affect line A. The currents in one direction pass to earth and to line (differentially), and in the other direction add to the discharge of E.

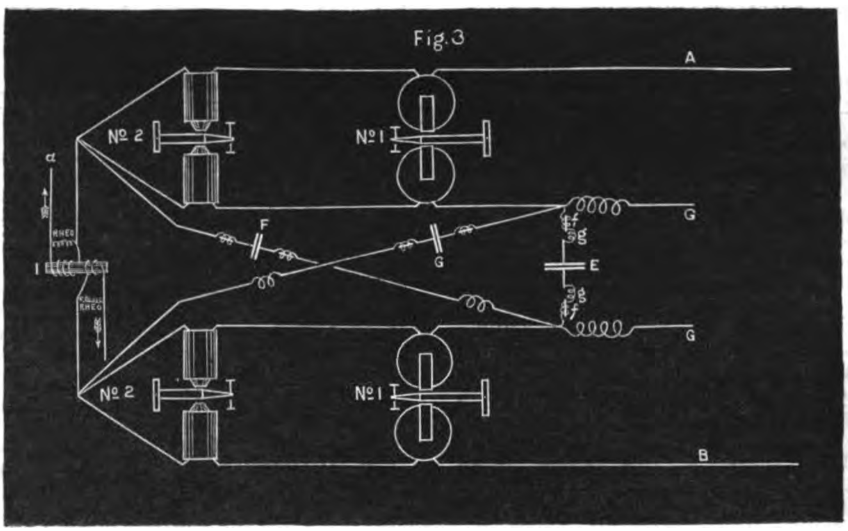
In the above arrangements as applied to the quadruplex, duplex, and other systems on the "bridge" and "differential" principles, it will be observed that nothing has been said of the inductive effects of the out-going current upon the relays at the distant station. On a line of any considerable length where the earth is used as a part of the circuit, the effects of induction do not seem so great at the remote terminal, and the induced current is found to flow opposite in direction to the current caused by the same influence at the "home station:" *i.e.*, when a current is sent into the line, the induced current which is generated and flows to earth at the remote end of the line, is in the same direction as the battery-current, while at the home station it is in the opposite direction. A brief explanation of this is as follows: When the current is sent to line, the latter gradually becomes charged, and as this action takes place the particles of matter in the adjacent conductors, by inductive action, are polarized, "the opposite kind of electricity being attracted and held bound, and the same kind repelled," which flows to the earth according to the law of derived circuits. When the battery current first enters the line, the maximum effect is felt at the home station, and, as it approaches the remote terminal, the effect gradually diminishes until the electrical centre of the other wire is reached, when the first effect is a minimum. From this time the effects at the remote terminal gradually increase until a maximum is reached, when the entire induction current ceases. Similar effects are produced when the current is withdrawn from the line, except that the polarized articles resume their normal condition, and therefore the induced currents will be in the opposite direction to those caused by the polarization. When a current of opposite polarity is sent into the line at the moment of withdrawing the first current, the particles not only resume their normal condition, but they immediately are again polarized, the electricity that was before bound being repelled, causing an opposite current to flow back through the relays.

If we suppose the first current sent to line to be +, the induced current caused thereby would also be +, but would flow in the opposite direction. Now, should the battery current be withdrawn, the induced current would again be +, flowing back to line. If at this moment a reversal should take place, the same effect, in addition to a — current flowing from the line would be the result. Of course a — current in one direction produces the same magnetic effect as a — current in the other direction, and, consequently, reversing the battery greatly increases the inductive interference.

It will be observed from the above facts that the requisite direction of the neutralizing current at one extremity of the line would only augment the interference if applied at the other extremity, and, therefore, the neutralizing current must produce opposite effects at the two terminals. The induction coil I., shown in Fig. 3, is used for this purpose. Its two constituent coils are so wound that the currents entering the two lines will flow around the core in the same direction, and thereby cause induced currents of the same kind as those flowing back from the line, and reverse to those flowing to earth at the remote terminal. These currents, when properly adjusted with regard to their *strength*, flow over the line and neutralize the effects of induction upon the remote relays, producing no effect upon the home relays on account of the location of the coil with reference to the differential arrangement.

I found that good results could be obtained by using a condenser made of two well insulated wires wound parallel, with less adjusting than was necessary with the tin-foil condensers. An instrument of this description has a more perfect resemblance to a telegraph line than the combination of electro-magnet and resistance coils, which are necessary to the arrangements when ordinary condensers are used.

With an instrument of this kind, constructed with two well insulated copper wires, the electro-static discharge of the No. 5 gauge wire, from Chicago to Buffalo (538 miles), has been compensated for when



this apparatus, with proper means of adjustment, was substituted for the combination of condensers ordinarily used for this purpose.

The electro-static charge of a telegraph wire, or any other conductor, is supposed to be caused by induction, "and without this induction the conductor cannot become charged." *

Assuming the above to be a fact, the charge of a telegraph wire must be mostly due to the influence of the earth—the dielectric being the atmosphere. Why, then, would not a smaller gauge-wire, nearer to the earth, have the same capacity as a larger wire a correspondingly greater distance away? Experiment has shown that it will, and it is thought that in the application of condensers in the construction of artificial telegraph lines, this form of condenser will give much better results than the combination with resistance coils at present used to accomplish a *gradual* discharge, which is the condition of the discharge of an actual line.

A SINGLE CURRENT DUPLEX TRANSLATOR.

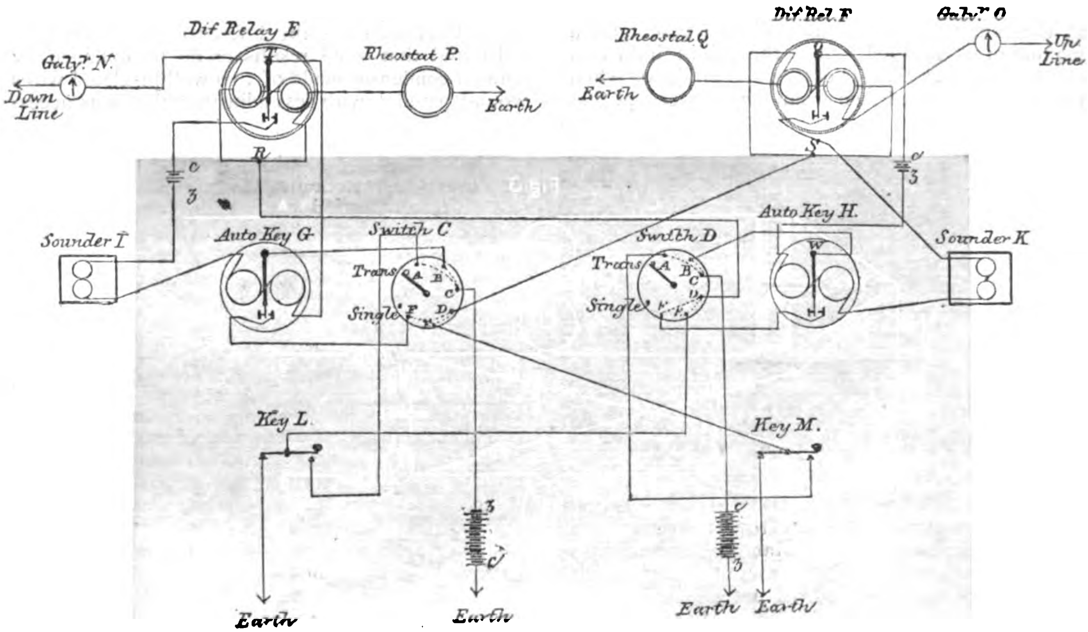
By W. DENNETT.

To the Editor of THE TELEGRAPHIC JOURNAL.

The enclosed is a sketch of a Single Current Duplex Translator, for your inspection. Very little explanation of the figures and manner of working, is necessary, as the subject is, no doubt, well known to all your readers.

The incoming current from the "Up" station passing through the differential relay F (Siemens' polarised), closes the local circuit in which another relay H is introduced as an automatic key, whose tongue W is connected to battery B, through switch D. Battery B supplies the power for the "Down" section, which dividing at R, circulates in equal and opposite directions in differential relay E, thus exercising no influence upon its tongue T.

Should the "Down" station be sending at the



The switch connections are as follows:—When the handles are turned to the left for translation, B and C are in contact, and A disconnected; D and F in contact, and E disconnected. When turned to the right for single working, or division of line, D and E are in contact, and F disconnected; A and C in contact, and B disconnected.

same time, the "Down" line current from B becomes neutralized, the compensation current then coming into force closes the local circuit, bringing battery A into use for the "Up" line by means of the tongue V of the automatic key G. The current from A dividing at S, as in the other case, completes the translation.

WM. DENNETT.

Dover P. O.

* Faraday.

THE ELECTRIC LIGHT AT NOTTINGHAM.

LAST night at 10 o'clock, in accordance with the arrangements made by the borough engineer, Mr. Tarbottom, Messrs. Siemens Bros., exhibited the electric light at the Health Committee's Wharf in the East Croft, London Road. The light was similar to that exhibited in the Market Place and at the Castle on Wednesday. The effect in and adjoining the wharf was satisfactory, every point being clearly illuminated. A number of gentlemen had been invited to attend on the occasion. Amongst those present we noticed Mr. Councillor Lindley (ex-Sheriff), Mr. Ald. Lambert, Mr. Ald. Woodward, Mr. Ald. Ford (Chairman of the Health Committee), Mr. Councillor Walker, Mr. Councillor Tutin, Dr. Seaton (Medical Officer of Health), Mr. W. Richards (Chief Sanitary Inspector of Nottingham). After the electric light had been exhibited for some time, those present retired to an adjacent office, when Mr. Tarbottom stated that originally it was intended that Messrs. Ball & Co. should illuminate, by means of their light which had been used by the French and English Governments. Large manufactories in Paris had been illuminated by electric lights, and it had been considered advantageous to apply it to those premises in order to see the effect of the application, in consequence of the results which had been produced in Paris. Messrs. Ball and Co., however failed to come forward, but fortunately the promoters managed to fall back on the firm of Siemens Bros., who made the necessary arrangements there in 18 hours. One of the lights was exhibited in the Market Place, and another at the Castle on Wednesday night, but those present had been invited to inspect the light as it was exhibited at the Works of the Health Committee.—*Nottingham Daily Express.*

We may remark that the apparatus employed by the English Government is the same as that exhibited at Nottingham, namely, Siemens' apparatus; and that several manufactories in England now employ Siemens' electric light in preference to gas.

REPORT OF THE AMERICAN COMMITTEE ON DYNAMO-ELECTRIC MACHINES.

THE Board of Managers of the Franklin Institute having empowered its Committee on Instruction to purchase a Dynamo-Electric Machine, it was deemed advisable to examine into the merits of, and to test, the various machines offered for sale. This was undertaken partly as a guide in making a selection for purchase, and also to obtain reliable data regarding the adaptability of such machines to the production of light.

In view of the scientific importance of the work, the Committee on Instruction, which consists of five members of the Board of Managers, availed themselves of the services of four other members of the same, who, by request, assisted in the investigation, and now join in this report.

The work was divided among sub-committees as follows:

On Photometric Measurements, Messrs. Briggs, Profs. Rogers and Chase. On Electric Measurements, Profs. Houston, Thomson, and Mr. Rand. (Mr. Rand's business engagements prevented his taking active part in the work of this sub-committee.) On Dynamical Measurements, Messrs. Jones, Sartain and Knight.

The source of power for the experiments was an upright steam-engine belonging to the Institute. It has 6" bore of cylinder, and 8" stroke, heavy fly-wheel 30" diameter, and governor so adjusted as to give speeds from 100 to 250 revolutions per minute.

The machines submitted to examination were as follows:—Their dimensions are given in Table I: A Gramme machine (similar in form to that given on page 191, Vol. V. of the *Telegraphic Journal*). A large and small Brush machine, which each have for their magnetic fields two horse-shoe electro-magnets, with their like poles facing each other, at a suitable distance apart, the circular armature rotating between them.

In each machine the currents are generated in coils of copper wire, wound upon an iron ring, constituting the armature. This ring is not entirely covered by the coils, as in the Gramme armature, but the alternate uncovered spaces between the coils are almost completely filled by iron extensions from the ring, thus exposing large surfaces of the armature ring for the dissipation of heat, due to its constantly changing magnetism, as in the Pacinotti machine.

The ring revolves between the poles of two large field magnets, the two positive poles of which are at the same extremity of the diameter of the armature, and the two negative poles at the opposite extremity, each pair constituting practically extended poles of opposite character.

The coils on the armature ring are eight in number, opposite ones being connected end to end, and the terminals carried out to the commutator. In order to place the commutator in a convenient position, the terminal wires are carried through the centre of the shaft, to a point outside the bearings.

The commutators are so arranged, that, at any instant, three pairs of coils are interposed in the circuit of the machine, working, as it were, in multiple arc, the remaining pair being cut out at the neutral point; while in the Gramme machine, the numerous armature coils being connected end to end throughout, and connections being made to the metal strips composing the commutator, two sets of coils in multiple arc are at one time interposed in the circuit, each set constituting one-half of the coils on the armature.

The commutator consists of segments of brass, secured to a ring of non-conducting material, carried on the shaft. These segments are divided into two thicknesses, the inner being permanently secured to the non-conducting material, and the outer ones, which take all the wear, are fastened to the inner in such a manner that they can be easily removed when required.

The commutator brushes, which are composed of strips of hard brass, joined together at their outer ends, are inexpensive and easily renewed. The high speed at which these machines are run, together with the form of the armature, cause the rotation of the latter to be considerably resisted by the air, and producing a humming sound, but otherwise they run smoothly; the heating of the armature being inconsiderable, not exceeding 120° Fahr.

after four and three-quarter hours' run. They are simple in construction, all the working parts being easily accessible, and the cost of maintenance low.

In the Wallace-Farmer machine,* the magnetic field is also produced by two horse-shoe electro-magnets, but with poles of opposite character facing each other. Between the arms of the magnets, and passing through the uprights supporting them, is the shaft, carrying at its centre the rotating armature.

This consists of a disc of cast iron, near the periphery of which, and at right angles to either face, are iron cores, wound with insulated wire, thus constituting a double series of coils. These armature coils being connected end to end, the loops so formed are connected in the same manner, and to a commutator of the same construction, as that of the Gramme. As the armature rotates, the cores pass between the opposed north and south poles of the field magnets, and the current generated depends on the change of polarity of the cores. It will be seen that this constitutes a double machine, each series of coils, with its commutator, being capable of use quite independently of the other; but, in practice, the electrical connections are so made, that the currents generated in the two series of armature coils pass through the field-magnet coils, and are joined in one external circuit. This form of armature also presents a considerable uncovered surface of iron to the cooling effect of the air, but its external form, in its fan-like action on the air, like that of the Brush, presents considerable resistance to rotation. In the Wallace-Farmer machine there was considerable heating of the armature, the temperature being sufficiently high to melt sealing-wax.

The opinions as to the comparative merits of the machines submitted for examination were as follows :—

1. The Gramme machine is the most economical, considered as a means for converting motive power into electrical current, giving in the arc a useful result equal to 38 per cent., or to 41 per cent. after deducting friction and the resistance of the air. In this machine the loss of power in friction and local action is the least, the speed being comparatively low. If the resistance of the arc is kept normal, very little heating of the machine results, and there is an almost entire absence of sparks at the commutator.

2. The large Brush machine comes next in order of efficiency, giving in the arc a useful effect equal to 31 per cent. of the total power used, or 37½ per cent. after deducting friction. This machine is, indeed, but little inferior in this respect to the Gramme, having, however, the disadvantages of high speed, and a greater proportionate loss of power in friction, etc. This loss is nearly compensated by the advantage this machine possesses over the others of working with a high external compared with the internal resistance, this also ensuring comparative absence of heating in the machine. This machine gave the most powerful current, and consequently the greatest light.

TABLE I.

SHOWING WEIGHT, POWER ABSORBED, LIGHT PRODUCED, ETC., BY DYNAMO-ELECTRIC MACHINES TESTED BY A COMMITTEE OF THE FRANKLIN INSTITUTE, 1877-8.

NAME OF MACHINE	Weight in pounds.	COPPER WIRE IN				Revolutions of Armature per minute.	Foot-pounds of power consumed.	Horse-power.	LIGHT PRODUCED IN STANDARD CANDLES.		Foot-pounds of power consumed per candle light.	Size of carbons.	LENGTH OF CARBON CONSUMED PER HOUR.	
		ARMATURE.		FIELD MAGNETS.										
		Size.	Weight.	Size.	Weight.				Total.	Per h.-p.			+	−
Large Brush ...	475	·081 in.	32 lbs.	·134 in.	100 lbs.	1340	107·606	3·26	1230	377	87·4	$\frac{3}{8} \times \frac{3}{8}$	1·78	.34
Small Brush ...	390	·063 in.	24 lbs.	·096 in.	80 lbs.	1400	124·248	3·76	900	239	137·	$\frac{3}{8} \times \frac{3}{8}$	1·91	·58
Large Wallace ...	600	·042 in.	50 lbs.	·114 in.	125 lbs.	800			823					
Small Wallace ...	350	·043 in.	18¾ lbs.	·098 in.	41 lbs.	1000	128·544	3·89	440	113	292·	$\frac{1}{4} \times \frac{1}{4}$	2·45	·073
Gramme... ...	366	·059 in.	9¼ lbs.	·108 in.	57½ lbs.	800	60·992	1·84	705	383	85·	$\frac{1}{4} \times \frac{1}{4}$	3·15	·55

3. The small Brush machine stands third in efficiency, giving in the arc a useful result equal to 27 per cent., or 31 per cent. after deducting friction. Although somewhat inferior to the Gramme, it is, nevertheless, a machine admirably adapted to the production of intense currents, and has the advantage of being made to furnish currents of widely varying electro-motive force. By suitably connecting the machine, as before described, the electro-motive force may be increased to over 120 volts. It possesses, moreover, the advantage of division of

* This machine is very similar to that of M. Breguet, shown on page 101, Vol. IV., of the *Telegraphic Journal*, with the addition, however, of the iron disc.

the conductor into two circuits, a feature which, however, is also possessed by some forms of other machines. The simplicity and ease of repair of the commutator are also advantages. Again, this machine does not heat greatly.

4. The Wallace-Farmer machine does not return to the effective circuit as large a proportion of power as the other machines, although it uses in electrical work a large amount of power in a small space. The cause of its small economy is the expenditure of a large proportion of the power in the production of local action. By remedying this defect, a very admirable machine would be produced.

The Committee regret that a machine of the Siemens' type was not placed at their disposal, since whatever value the determinations may possess, they would then have been increased by embodying data concerning a machine so widely and so favourably known, especially as the Siemens machine employs an armature differing in construction from that of any of the machines examined, wire only being revolved, a construction which theoretically favours economy in working.

ON THE SPECIFIC INDUCTIVE CAPACITIES OF CERTAIN DIELECTRICS.

By J. E. H. GORDON, B.A., Camb. First Series. Communicated by Professor J. CLERK MAXWELL, F.R.S.

THE author has, under Professor Clerk Maxwell's directions, carried out some measurements of specific inductive capacities by a new method. The essential features of it are:—

(1.) It is a zero method.

(2.) The electrified metal plates never touch the dielectrics.

(3.) No permanent strain is produced or charge communicated, as the electrification is reversed some 12,000 times per second.

The potentials of the electrified plates were about equal to that of 2,000 cells.

The following are the results obtained:—The solid dielectrics were plates 7 inches square, and from ¼ inch to 1 inch thick.

Dielectric.		Specific Inductive Capacity.	
Ebonite, 4 slabs of thicknesses ¾, ½, ½, ¼ inch, about.	(1.)	1·5593	Mean ...1·56215
	(2.)	1·5553	
	(3.)	1·5671	
	(4.)	1·5669	
Best quality gutta percha		1·5939	
Chatterton's compound		1·6080	
India-rubber, black		1·5502	
India-rubber, vulcanised		1·5988	
Sulphur		1·6127	
Shellac		1·6362	
Solid paraffin, sp. gr. ·9109 at 11° C. Melting point 68° C. 6 slabs, each ¾-inch thick, about	(1.)*	1·4986	Mean... 1·49753
	(2.)	1·4943	
	(3.)	1·4920	
	(4.)	1·5033	
	(5.)	1·4936	
	(6.)	1·5034	

* These results are corrected for cavities in the plates. The mean of the uncorrected determinations is 1·4864.

†Bisulphide of carbon			1·4474
Chance's optical glass. Slabs nearly 1 inch thick.	Double extra dense flint		1·6840
	Extra dense flint		1·6727
	Light flint		1·6677
	Hard crown		1·6872
Common plate glass, 2 slabs, each 1 inch thick, about.	(1.)	1·6933	Mean...1·6918
	(2.)	1·6903	

The author suggests that the fact that all his results are much lower than those obtained by previous experimenters may perhaps be explained on a supposition that the specific inductive capacity of dielectrics increases from an inferior to a superior limit during the first small fraction of a second after the commencement of the electrification. He discusses this question at some length in his paper.

An expression of thanks to Professor Maxwell, for his close superintendence of the work, concludes the paper.—*Proceedings of the Royal Society*,

† I cannot vouch for the exact accuracy of this determination as the method of experimenting on liquids is not yet quite perfect.

Reviews.

Journal of the Society of Telegraph Engineers. No. XXI., Vol. VII. E. and F. N. Spon, London and New York.

THE contents of this number bring the records of the society's proceedings down to 27th February, 1878. Commencing with the inaugural address of the president (Dr. C. W. Siemens), the number shows that the following papers have been read before the society:—

"The American Telegraph System," by Mr. W. H. Preece, V.P.; "A Chloride of Silver Element as a Standard of Electro-motive Force," by Dr. A. Muirhead; "Dr. De la Rue's Chloride of Silver Battery," by Latimer Clark, Past President; "Byrne's Pneumatic Battery," by Mr. W. H. Preece, V.P.; "The Logograph," by Mr. H. Barlow, F.R.S., V.P., Inst. C.E.; "The Phonograph," by Mr. W. H. Preece, V.P.

After an Obituary notice of Samuel Carter, Esq., honorary member, Original Communications, Abstracts, &c., as follows, complete the number:—

"Gaston Planté's New Electrical Machine," by Alfred Niaudet; "The Wire Finder," by John Gott; "Automatic Curb-signalling applied to the ordinary hand keys for use on Submarine Cables," by John Gott; "On a Union or Binding Screw for Temporary Joints," by Arthur M. Stiffe; "On a Standard Voltaic Battery," by Latimer Clark; "On the General Theory of Duplex Telegraphy," by Louis Schwendler.

A Handbook of Practical Telegraphy, by R. S. CULLEY, seventh edition, revised and enlarged. London: Longmans, Green, Reader, and Dyer, 1878.

ADDITIONS made in the present edition of this work bring the total number of its pages to 468. The increase has added considerably to the value of the work, giving as it does useful details of some of the most recent advances made in telegraphy, such as

"Fast Speed Translators," "The Telephone," and "Quadruplex Telegraphy."

But whilst Mr. Culley has done good service by making these additions, it is a pity that he did not at the same time recast the general arrangement of matter in the volume so as to connect the various matters dealing with any particular subject somewhat more closely, instead of merely tacking on the additions in a rather disjointed manner. A more copious index might also with advantage have been compiled.

Taking the book as a whole it is very free from extraneous matter, though we occasionally meet with the mathematical developments which are supposed to give valuable assistance in the construction of a line of telegraph. Thus on page 141 *et seq.* we meet with tables for calculating the strains of suspended wires and their stress on struts and stays. We can quite picture to ourselves the intelligent inspector or construction foreman with handbook in hand sitting down to calculate the particular stay he must give to any particular span, or the exact angle at which he must set the stay and the strut so as to properly secure the pole; but although these utterly useless tables appear in the book, yet, as we have said, the work is singularly free from such matter, and, as a rule, only thoroughly practical information is given; to this no doubt the success of the book has been largely due.

In the chapter on "Apparatus and Systems of Signalling," Mr. Culley points out the cause of the diversity of the forms of instruments in use in the postal telegraph service of the United Kingdom. The cause in the first place was due to the fact that, prior to the transfer, the several companies who worked the telegraph system, as it then existed, each had their own special methods; methods, no doubt, due to the caprice of the engineer of the particular company. When the transfer took place, it was of course impossible to produce uniformity without entirely reconstructing the plant. Again, the undertaking being national, it had to be extended to remote villages, too small to give a specially trained clerk the practice needed to keep up his skill, far less to pay his salary. The present arrangement is this, to quote Mr. Culley's own words:—

"In villages where the telegraph must be worked by the postmaster or one of the family, the alphabetical dial instrument is used, because it requires no previous training whatever.

"When the traffic is just large enough to employ a trained clerk of the lowest grade, one who can work his instrument but who cannot put it in order should it fail, the needle is used because it needs no adjustment, and very rarely gets out of order, even when a considerable number of stations are in circuit.

"When the business is larger, the needle would be too slow, and the Morse system, either sounder or recorder, is used."

When the business is still larger the duplexed Morse system or the automatic systems are employed.

Although Mr. Culley's book is not a record of telegraph work as it is carried on in different parts of the world, nor, indeed, is it intended to be so, yet it is a faithful record of the very complete system of the United Kingdom, and from this system being a good one, it follows that the information contained n the work must be valuable to those who desire to gain a knowledge of practical land telegraphy.

Notes.

THE TELEPHONE.—A double effect is obtained by holding a telephone to each ear in listening, when the telephones are looped together in "multiple arc," and line is joined to one, while earth is connected to the other.

IT has been found by M. des Portes of the French war-ship *Desaix* that if one telephone of a Bell telephone circuit be deprived of its diaphragm, and freely suspended, a blow given to the bar magnet is heard as a distinct sound in the other or receiving telephone. If the blow be struck with copper or iron, the sound is louder than when struck with wood; and if it be struck by a magnetised piece of iron, a similar effect is heard to that given by soft iron, if like poles be knocked together; but if unlike poles be knocked together, a second and fainter sound is heard when the striking pole is withdrawn. The person at the receiving telephone soon learns to distinguish with what kind of material the blow is struck. In every case the soft iron diaphragm of the telephone, replaced in contact with the coil pole of the transmitting telephone, intensified the sounds heard in the receiving telephone. This is in accordance with its function as an armature.

PROFESSOR ROSETTI of Venice, while experimenting recently with a telephone having a loose coil, found the latter to oscillate along the magnet when a discontinuous current passed in the coil. This motion is evidently due to action and reaction between the coil and the magnet. The above results of M. des Portes and that of Professor Rosetti support the hypothesis of Count du Moncel, that the sounds of a receiving telephone are produced molecularly in the core or magnet itself, and only reinforced by the action of the diaphragm.

IT is said that the Western Union Telegraph Company, U.S., find the best telephone arrangement to be an Edison carbon, or rather charcoal, transmitter, with a Gray electro-magnetic receiver. Since Edison substituted prepared charcoal for carbon in his telephone, it has given better results. This combination gives far louder speaking than two of Bell's telephones. Gray's electro-magnetic receiver was patented in America on the same day as Bell's, but to Bell belongs the credit of making an electro-magnetic transmitter.

THE telephone has been adopted on the mountain section of the Central Pacific Railway, Nevada. Box telephones are connected up every few miles along the track, and the track-walkers report by these to a central office at Blue Canon.

THE MICROPHONE.—Mr. W. J. Millar, C.E., Glasgow, forms an excellent microphonic receiver out of a bar magnet, wound *lengthwise*, with a few yards of No. 30

copper wire. Tuning-fork sounds, singing, whistling, speaking, and violin music were heard distinctly by this simple arrangement.

ON another page we give an account of Prof. Hughes' special microphone for receiving sounds.

MESSRS. PITT AND DOPP, Central School Laboratory, Buffalo, U.S., June 11th, writing to the *Scientific American*, state that a microphone made of a glass tube, filled with No. 12 small shot, acts as a telephone receiver, the sounds being heard by placing the neck of a common glass funnel to the tube, and holding the bar to the cone. They claim to have been at work on the microphone problem for the last six months.

A MICROPHONE, placed on the vibrating diaphragm of a phonograph, transmits the sounds vibrated by the latter to a distance. Has it occurred to anyone yet to reverse this process, and record on a phonograph the inaudible sounds made audible by the microphone?

MR. C. E. DE RANCE, F.G.S., of H. M. Geological Survey, has written to the *Times*, suggesting the application of the microphone as a detector of gas escape in coal mines. The gas issuing from rifts in the coal makes a hissing sound, which, by means of a microphone, telephone, and phonograph, might be registered by night at the pit-head.

WE are indebted to M. de Sussex, Brussels, for some interesting facts about a microphone of his construction. It is an adjustable one, and consists of a small square block of retort carbon, fixed on an empty cigar box, which makes a convenient resonator. A rectangular stick of carbon is supported horizontally over this block by a horizontal spring, so that the end of the stick rests upon the top of the block. A thread attached to the spring is wound round a screw-head, and can be tightened or slackened, so as to increase or diminish the pressure of the stick or upper carbon on the block. To speak with this microphone the carbons ought to be pressed closer than when minute sounds, such as the ticking of a watch, are transmitted. Curiously enough M. de Sussex finds that if a drop of acidulated water be put between the two carbons the sounds are much increased, but the water polarises very quickly, and it becomes necessary to allow the carbons to dry again. This is a very interesting fact.

THE PHONOGRAPH.—It is said that Edison has improved the phonograph so that if spoken to at a distance of 13 feet it will intelligibly reproduce the speech. This increased sensitiveness is largely due to steel bearings having been supplied to the cylinder, so as to give it unvarying uniformity of motion.

PROFESSOR MCKENDRICK, Glasgow, believes that a thin and slightly elastic membrane is the most suitable for giving loud phonograph utterance, a rigid non-elastic membrane being best adapted to give distinctness. From a consideration of the structure of the drum of the ear this is what should be expected.

THE phonograph may bottle up the voice and pass it down to future ages; but the smile that twists the face of a man as he seeks a solitude and gazes upon his name in print for the first time will always have to be guessed at.—*Detroit Free Press.*

LATIN is said to be the language which gives the best results with the phonograph.

SPEECH may be elevated to a whistle by turning the phonograph recording it fast enough, and the whistle may be recorded by a second phonograph, revolving slower, so as to give out the original sound.

THE MEGAPHONE.—The latest as well as the most curious of Mr. Edison's inventions is the megaphone, for which he has but just filed his *caveat*. It is a sort of sound opera glass. By means of its use persons partially deaf are enabled to hear the faintest sound with distinctness. It concentrates and multiplies the sound in as high a degree as is required. By applying it to the ear at a high rate of adjustment a whisper can be distinctly heard 300 feet away. Mr. Edison has already tested it sufficiently to be satisfied of its entire practicability. It is to be of small size, and have attached to it a rubber tube. In the inventor's own words "It can be taken to a theatre by a person hard of hearing, just as a person now takes his opera glass. All you do is place it on your lap, let the tube touch your ear, and all sounds come to you magnified fifty times if necessary. The loudness can be regulated for the ear as you regulate a telescope for the eye."—*The Operator.*

THE EASTERN TELEGRAPH COMPANY have made arrangements with her Majesty's Government and the Government of the Sultan for the extension of the company's cable system in the Levant. Several sections have already been laid, and the other sections are in progress. Part of the cost of these works has been paid by the English Government, and the balance is expected to be defrayed by the company without the issue of fresh capital. The cable from Tenedos to Constantinople is now laid.

A MEETING of South African merchants presided over by Mr. Donald Currie was recently held at Cape Town to press upon the Home Government the necessity of an early cable connecting England to South Africa, leaving it to the Government to settle whether it should be an east or a west coast cable.

EDDYSTONE LIGHTHOUSE.—A deputation from Plymouth had an interview on Friday with Lord Sandon, at

the Board of Trade, to ask the Government to erect a telegraph station at the new Eddystone Lighthouse. A memorial having been presented, and speeches delivered on the subject, Admiral Sir R. Collinson, from the Trinity House, said they did not consider it necessary, and Mr. Patey, from the General Post Office, expressed the same view. Lord Sandon said it was not a very simple matter. As to the signal station, he agreed abstractly that with a great shipping nation like ourselves the more stations the better, and he quite understood that Plymouth should wish to have it for her own purposes. He saw the local reasons quite clearly. But the question arose whether it was not merely a local matter, and not one which ought to be taken up by any public body. So far as he had been able to ascertain there was no precedent for the Mercantile Marine Fund being used for such a purpose, and he should be loth to set the precedent of using it for a purpose for which it was not intended. He would be quite ready to consider an application from Plymouth to lay the wire to the lighthouse, providing that the men put there and the signalling were completely under the control of the Trinity House; but he could not promise anything in the matter.

Some postal and telegraph reforms have just been carried out in Mauritius. The charge for a message of twenty words is reduced to 25 cents., an example which might be held up to India, where an inland message of six words costs 50 cents. An extra charge is made for messages on Sunday, a proceeding which our contemporary the Port Louis *Mercantile Record* cannot possibly understand.

A deputation consisting of the chairman, directors, and secretary of the West India and Panama Telegraph Company waited upon Sir Michael Hicks Beach, at the colonial office recently, upon the subject of telegraphic communication with the West Indies.

The Great Northern Telegraphic Company's Amoy-Shanghai Cable is interrupted, so that messages for Hongkong and Amoy (Foochow) cannot be accepted. During this interruption the Company's line is the only Telegraph route to Shanghai, and to all stations in Japan.

We are glad to learn that a movement is on foot to present a testimonial to Mr. Paul Le Neve Foster, on the occasion of his completing his twenty-fifth year of service as Secretary of the Society of Arts.

Our contemporary *La Nature* reports, that during a recent thunderstorm at Saint-Révérien (Nièvre) a stroke of lightning entered a dwelling house by the chimney, upsetting several dishes, and, oddly enough, boring its way through a pile of plates, missing each alternate plate. Moreover, the bolt escaped by a window, breaking the glass in pieces. A girl sitting in the doorway was paralysed in her legs by the shock.

Mr. W. R. Plum, a Chicago attorney, but formerly a practical telegraphist, is collecting materials for a history of the United States Military Telegraphic Service. It will be remembered that the late American Civil War was the first occasion on which telegraphy played an important part in warfare, and the work proposed, if well done, should be a most interesting one.

Fire Telegraphs in New York.—An improved fire alarm system, arranged by Messrs. Emrich and Smith, is now in operation at Fireman's Hall, New York. It comprises 60 circuits of 120 wires, 550 street boxes, and 85 stations connected up to head quarters. The wires are connected through lightning arresters to a main switch board of slate 16 ft. long by 3 ft. wide, containing 800 switches. A galvanometer is connected up in each circuit to show at all times the strength of current in it.

A suit between the Atlantic and Pacific and Western Union Telegraph Companies, U.S., about their rights to the employment of Prescott and Edison's Quadruplex, has just been decided against the former company. It appears, from the *Operator*, that Edison has made five contracts in this matter, first in 1871, assigning half his interest in all inventions in "automatic" telegraphy to Mr. Harrington, of the *ci-devant* Automatic Telegraph Company, for the ensuing five years; and, secondly, supplementing this by giving up the whole of his interest in said inventions. These contracts, which had been considered inoperative since the break-up of the Automatic Company, passed by sale through several hands, finally coming into the possession of the Atlantic and Pacific Company. In 1873, Edison made a contract with the Western Union Company, who facilitated his experiments, giving to them his prospective inventions in duplex and quadruplex. Next year he made a fourth contract, assigning to Mr. Prescott half of his own interest in duplex and quadruplex, on condition that they should work together at it. When the quadruplex was perfected in 1874, it was offered to the Western Union for 25,000 dollars cash, and 233 dollars for each circuit on which it was used. Mr. Orton was absent from New York at the time, and some delay took place. Meanwhile, Mr. Edison, in January, 1875, contracted with the A. and P., and assigned his inventions in duplex and quadruplex to them for 30,000 dollars. About the same time Mr. Orton accepted Edison's above offer on behalf of the W. U. Company. Mr. Edison, in reply to Mr. Orton, said he was advised that the previous contract with Mr. Harrington would prevent his assigning the patents to the W. U. The A. and P. brought up the suit, and claimed that its right to duplex and quadruplex was included in the 1871 contract with Harrington; but Judge Sanford ruled that this was not the case, and legalised the W. U. claims.

MISHAPS OF TELEGRAPH LINES.—M. Lohse has published in the *Archir fur Post und Telegraphie* (1877, 298) on the subject of faults in the German telegraph lines, a very detailed account, from which we extract the following facts. The year had not been a favourable one for the lines; the hurricanes, from the 12th to the 13th of March, and from the 12th to the 13th of November, having caused considerable damage. The first of these hurricanes put temporarily out of service nearly two-fifths of all the lines. The total number of derangements during the year was 6,198, of which 87 per cent. were country lines, 7 per cent. town lines, 1½ per cent. cables, and 4½ per cent. office leads. . . . On grouping the faults according to their causes, we find that 26 per cent. were due to atmospheric influences, 15 per cent. to falling rocks, or earth slips, 3 per cent. to mischief or carelessness, $\frac{3}{10}$ per cent. to the flight of birds against the wires, or kite strings. The remaining $54\frac{7}{10}$ per cent. could not be accounted for. The faults were 1,708 broken posts, 3,284 broken wires, 4,114 damaged insulators, 2,706 broken binding wires. The system in which they occurred only comprised in the year 1876, 37,264 kilometres of line, involving 136,891 kilometres of wire. There was, therefore, a broken post for every 21·7 kilos. of line, a broken wire for every 41·7 kilos. of wire, and a leakage for every 31·2 kilos. of wire.—*Journal Telegraphique.*

Patents.

2527. "Telephones."—C. W. SIEMENS (communicated by W. Siemens), June 25.

2554. "An improved telegraphic apparatus."—C. A. BRAMAO, June 26.

2640. "Improvements in and connected with magnets to be used for separating metallic substances from materials used in the manufacture of pottery and other manufactures."—E. LEAK and J. EDWARDS, July 2.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

4059. "Circuit closers for electric alarms" (communicated by S. S. Applegate). Camden, New Jersey, U.S. Dated November 1, 1877. 6d. This consists in a portable circuit closer or key, which may be fixed in any position, such as the door-mat or window of a house. The device for a mat consists of short elliptic metal springs fixed to a number of wooden slats secured to the mat. The springs yield to pressure, and are pressed by the footfall of a passenger into contact with two metal contact pieces, thus completing the circuit, and actuating an alarm.

4232. "Magnetic apparatus for ringing bells."—GEMINIANO ZANNI. Dated November 13, 1877. 6d. Improvements on a former patent of the author's, No. 2721, 1871, whereby the circular magnets therein described are dispensed with, and a horse-shoe electro-magnet substituted.

4275. "Producing electric light."—F. W. HEINKE. Dated November 15. 2d. This describes the employment of two carbon discs as electric wicks rotating by clockwork opposite to one another. The carbons are regulated by means of the clockwork or by the indraught of air caused by the combustion of the carbons. For this purpose the latter are enclosed in glass or metal cases with holes or tubes in them to direct the indraught so that it can rotate a fan. (*Not proceeded with.*)

4321. "System of double telegraphic transmission."—J. X. E. SIEUR. Dated November 19, 1877. 6d. The principle of this invention is as follows:—A cam, connected to earth, is caused to revolve rapidly between two contact springs, one of which is connected to the positive pole of the battery, the other to the negative pole. These springs are thus caused to oscillate rapidly to and from their respective contacts—the one of which is connected to one signalling key, the other to the other signalling key. Both of these keys are connected to one line wire, which thus receives positive intermittent currents from one key, and negative ones from the other. The receiving instruments are a pair of polarised relays, one of which responds to positive and the other to negative currents. Thus one message is received on one relay, and the other on the other relay. By employing the duplex mode of arrangement, a quadruplex system of transmission may be obtained.

4341. "Applying wires for conveying electricity."—ALEXANDER GRAHAM BELL. Dated November 20, 1877. 4d. This consists in overcoming the inductive disturbances from extraneous lines on telephone circuits by using a return wire very close to the outgoing wire.

4402. "Telephone."—J. A. EWING and Prof. FLEEMING JENKIN. Dated November 22, 1877. 2d. This consists of wires or groups of wires capable of vibrating to definite musical notes, stretched so as to vibrate across the lines of magnetic force, the circuit being always closed. The electric vibrations set up at one end give rise to similar vibrations at the other. By grouping the wires, a number of audible signals may be given without interference. (*Not proceeded with.*)

Correspondence.

[We do not hold ourselves responsible for any opinions expressed by our correspondents.—ED. TEL. JOUR.]

THE MICROPHONE AND THE TELEPHONE.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I have noticed in several recent American newspapers, references to the lectures upon Professor Hughes' microphone, which were delivered before the Society of Telegraphic Engineers and other institutions a few weeks since by Mr. W. H. Preece, in which not only is the credit of the invention or discovery of Hughes claimed for Mr. Edison, of New Jersey, U.S.A., but it is directly charged that Mr. Preece, in violation of confidential communications made to him previously by Edison, had imparted the knowledge of the same to Professor Hughes, thus enabling the latter to announce the discovery in Europe as his own.

It is wholly unnecessary for me to undertake to vindicate the reputation of either Mr. Preece or Professor Hughes in a community in which both gentlemen have been well known for at least 20 years.

I trust you will allow me the space to make public the facts, the overlooking of which appears to have led Mr. Edison, no doubt with entire sincerity, to make reflections on the two gentlemen named, and to which a syndicate of sensational American newspaper writers has given an unfortunate currency. The statement of these facts will dispose of these reflections, and at the same time correct an erroneous opinion quite general in Europe in regard to the origin of the invention of the speaking telephone.

On the 14th day of February, 1876, Elisha Gray, of Chicago, filed in the United States Patent Office, a *caveat* with drawings annexed, which show that he not only apprehended the principle of the articulating telephone at this date, but that he had actually devised a practical speaking telephone, depending on a method discovered by him for *controlling the resistance of a constant current by varying the contact surface between two conductors, one of them being thrown into vibration by the action of the voice upon the atmosphere.* This *caveat* of Gray was the *first document ever placed on record anywhere* describing an articulating or speaking telephone with complete drawings of an operative apparatus.

On the 30th July, 1877, Mr. Edison made a provisional application for protection in Great Britain for his speaking telephone. In this document he described many forms, and whilst he made known a principle and devices entirely original with himself, all the forms described by him involved the principle so fully set forth above, as in Gray's *caveat*, viz., that of controlling the resistance of a constant circuit by the action of the sound waves. He also described a method of regulating the resistance of the circuit by the amount of contact surface between two conductors, one of them being moved by the diaphragm, and this was also Gray's invention. The new fact discovered and announced by Edison was that *the specific resistance of a piece of carbon is altered by variations of pressure.*

It is thus evident that the principle that is common to Edison and Hughes was set forth in the *caveat* of Gray, eighteen months before Edison's application was made in Great Britain, and it is clear that, thus far, the facts and principles involved, considered according to the order and the source of their development, afford no basis for the complaint that has been made. I ask attention now to the single point of the invention of Hughes, that is not either covered by Gray, or common both to Hughes and Edison.

Professor Hughes discovered that when a chain of separate conductors were placed lightly in contact with each other, forming a circuit, the slightest vibration communicated to them would cause a wide variation in the resistance. In this manner he was enabled to produce results that were not possible with the apparatus either of Gray or with that of Edison.

If there has been any breach of confidence on the part of Mr. Preece, or any unfair appropriation of Edison's inventions by Hughes, it can have taken place only on this one point. In all the loose discussions in the American newspapers, no such specific charge has been made, and it is fair to assume that no ground for it exists; and, above all, no assumption, injurious to gentlemen so well known in both hemispheres, should be entertained for a moment without the specific allegation to this one point, and the production of the proofs..

From a careful consideration of the facts and principles involved, I have arrived at the conclusion, in which I think you will agree with me, that this unpleasant affair originated first in misconception of the actual questions at issue, and, second, in the rather excessive sensitiveness that all inventors are supposed to be subject to in respect to conflicting claims to priority. FRANK L. POPE.

Paris, June 28th, 1878.

General Science Columns.

CONTINUOUS BRAKES.

PART IV.

CLARK AND WEBB'S BRAKE.

Clark and Webb's Brake, which is an improvement upon Clark's Chain Brake, has attained some notoriety from its adoption so persistently by the North-Western Railway in spite of the repeatedly expressed opinions of the Board of Trade as to its inefficiency as a continuous brake at the present day, when more efficacious brakes are in daily use on other lines, which have repeatedly proved their greater value and usefulness. In this brake a chain, or steel rope, runs the entire length of the train, underneath the carriages, terminating in the guard's van, by means of which the brakes are applied to the wheels of every carriage. With this brake the train is usually made up in sections, each of which is supplied with a brake apparatus. Each carriage is provided with its own length of chain and couplings. The chain passes over seven pulleys fixed under the framings of the carriage, and under one pulley carried by levers in connection with tension rods attached to the brake blocks. When a chain throughout a section is coupled up, one end of it is made fast to the end of the extreme carriage of the section, whilst the other is led to a chain barrel hung under the framing of the guard's van at the other end of the section, close to the centre axle of the van. On the chain barrel, and also on the van axle, there are friction wheels, and by releasing a weighted lever in the van the friction wheels are brought into contact, and, if the van is in motion, the chain barrel is made to rotate. By this means the chain throughout the section to which the barrel belongs is tightened, the pulley carried by levers under each carriage is raised by the chain, and the brakes are applied to the wheels. The van from which the brakes of a section, both in front and behind of it, are actuated has two chain barrels set in motion by the release of one weighted lever. To release the brakes, the guard in each van has to put back the lever into its normal position, and secure it with a catch, at the same time releasing the brakes by a weighted lever arranged for the purpose. In order to place the brakes of a whole train at the command of the driver, a cord is passed over the roof of the carriages to the engine, by means of which the driver is enabled to release the catch holding the weighted lever in each guard's van, but the guards can only apply the brakes to their own section. The application of this brake being dependent upon the winding in of the slack rope or chain, it necessarily follows that its action must be both slow and gradual, in proportion to the length of each section of the train. Its mean retarding force also is not high, having been proved by the Commissioners to amount only to 7·79 per cent. of the gross train load with the use of sand, and 6·21 per cent. without sand. In effective power this brake took the next place after the Westinghouse

Automatic, the distances within which the train was brought up being, with sand, at 30 miles an hour, 385 feet; at 45 miles, 866 feet; and at 60 miles, 1,540 feet; without sand they were 480 feet, 1,080, and 1,920 feet respectively, in this latter instance being slightly behind Barker's Hydraulic Brake. Writing to the London and North Western Railway Company on the subject of an accident which occurred on the 15th August last, between the Moor and Warrington stations on that line, the secretary to the Board of Trade remarked that although the brakes on six vehicles were applied at least 1000 yards from the point of danger, and the engine was reversed at least half a mile from that point, the brakes on two or more vehicles were applied at 300 yards, and those on the remaining vehicles at 250 yards, the train had yet a residual speed of from 4 to 6 miles an hour when the point was reached; and this it is added, "happened to one of the most important express trains running on one of the most important trunk lines in the United Kingdom. These facts," it is further remarked, "amply prove that the brakes used by the company cannot in any reasonable sense of the word be called continuous brakes, and that they are not under the control of the driver. They are merely sectional brakes under the control of different persons in different parts of the train, and there are no sufficient means of communicacation between those different persons, so as to enable them to apply the whole of the brakes at the proper moment."

BARKER'S HYDRAULIC BRAKE.

The hydraulic apparatus applied by Barker to actuate railway brakes comprises a double acting steam accumulator on the engine, consisting of a large sized cylinder with a piston in it connected with a plunger working in a second cylinder, which is kept filled with water from the tender-tank. The piston in the former is actuated by pressure direct from the boiler, without the use of any pump, and in making its stroke the plunger in the smaller cylinder is made to force water, with any degree of pressure, into pipes leading from small hydraulic rams attached to the engine and carriage brakes. These pipes are continued the whole length of the train; the connections between the carriages being made with india-rubber hose furnished with ordinary unions. Each carriage is fitted with two of the hydraulic cylinders and rams, which are connected directly to the break-blocks in such a manner that on the ram of each cylinder being moved by the pressure of water from the accumulator, the break-blocks on one side of the pair of wheels to which the ram belongs are forced against the wheels, while the pressure of water against the bottom of the same cylinder causes it to recoil, as it were, and draw the tension rods of the brake-blocks on the other side of the pair of wheels, thus clipping each wheel between its two blocks. By reverse action in the accumulator the pressure in the brake cylinders can be relieved, and the blocks taken off from the wheels. The amount of pressure in the pipes can be regulated by a reducing valve; also, in order to keep the power always ready for immediate use, it is an essential part of this system that the pipes and cylinders throughout the train should be always full of water. In the event of a leak occurring in any part of the pipes the efficiency of this break would, no doubt, be seriously interfered with, but when in proper working order it is a very powerful brake. If a coupling breaks, however, the rear portion of the train is placed beyond control by the continuous brake. In experiments made to test the time required for the brake to be put into action, it was found to occupy from 3 to 5½ seconds before exercising its full power, and from 8½ to 18½ seconds to take off. The mean retarding force was found to be 7·64 per cent. of the gross load with the use of sand, and 6.47 per cent. without it. The distances run by the experimental train before being brought to a stand were greater than with the Clarke and Webb Brake when sand was used, but somewhat less without sand; they were as follows: with sand, at 30 miles an hour 393 feet; at 45 miles, 884 feet; and at 60 miles, 1,572 feet; whilst without sand they were 465, 1,046, and 1,860 feet respectively.

SANDERS VACUUM BRAKE.

The brake known as the Automatic Vacuum Brake has, for some time past, been in operation on the Great Western Railway, but few particulars of its working have been made public. In the application of the principle adopted by Mr. Sanders, a pipe extends under the carriages the whole length of the train, the pipes of each carriage being connected together by flexible couplings. In this pipe a vacuum is created by means of an ejector on the engine, and it is subsequently maintained by an exhausting pump, worked from a reciprocating part of the engine. The function of this pump is, therefore, not to create the necessary power, but to maintain it by withdrawing the air, which must of necessity find its way into the pipes through leakage. On each carriage are two drums with flexible heads, of different areas, which, being connected with the continuous pipe and to the brake gearing, pull in opposite directions. The larger drum of the two is employed to keep the brakes out of action, and the smaller one for applying them. In the connection between the smaller drum and the continuous pipe is a self-closing valve. The action of the brake is as follows:—When the vacuum is created in the continuous pipe, the air is simultaneously withdrawn from both drums, but the pressure of the atmosphere acting upon the head of the larger drum overbalances that upon the head of the smaller one. As they are both connected to the opposite ends of the same lever, the difference of power in the larger drum over that of the smaller is constantly employed in keeping the brakes out of action. In order to apply them it is necessary to destroy the vacuum in the larger drum, which is done by admitting air into the continuous pipe by means of a valve on the engine or in the guards' vans, or by an accidental separation of

the train or disconnection of the couplings between the carriages. The admission of air into the continuous pipe does not, however, destroy the vacuum in the smaller drum on account of the valve before described sealing it; a valve is, however, provided for admitting air to the smaller drum if necessary. The action of the two drums is as follows:—The effective power of the larger or releasing drum is 380 square inches × 10 lbs. vacuum = 3,800 lbs., whilst that of the smaller or applying drum is 314 inches × 10 lbs. = 3,140 lbs. There is, therefore, with a 10 lbs. vacuum, an excess of power equal to 660 lbs. in each releasing drum, acting in the direction of keeping the brakes constantly out of action. When the normal vacuum in the continuous pipe is reduced, say 17½ per cent., the two drums are put into equilibrium; but this diminution of pressure does not apply the brakes, because the larger drum is still pulling with equal power against the smaller. The brakes can only be put on by still further reducing the vacuum in the larger drum; and, in proportion to such reduction, the applying drum is permitted to apply them. The following are the results of experiments made with this brake on the Great Western Railway last January:—The train consisted of an engine, tender, five carriages, and two guards' vans, the total weight being 166 tons 12 cwts. The first stop made was on a falling gradient of 1 in 754, speed 56 miles an hour, and the vacuum at 16½ inches; the train was brought to a stand in 40 seconds after the first application of the brake, during which time it ran a distance of 1,931 feet. The second experiment was also on a falling gradient of 1 in 754. The speed was 47 miles an hour, and the vacuum gauge denoted 18½ inches. A stop was made in 28 seconds in a distance of 1,173 feet. The next was on a rising incline of 1 in 660, speed 51 miles, vacuum 19½ inches, the distance run, after application of the brake, was 1,245 feet in 30 seconds. Lastly, the train was brought up on a rising gradient of 1 in 834, the vacuum being 18½ inches; the time taken to effect a stoppage this time was 28 seconds, and the distance run, after the application of the brakes, 1,110 feet.

PROPERTIES OF GALLIUM.—Crystals of gallium are formed by introducing a platinum wire carrying a small grain of solid gallium into the metal, cooled some 10° or 15° C. below the point of fusion. It is hard and immalleable. Under the hammer it lengthens and takes the polish of the anvil, but it rapidly breaks asunder. Despite its high degree of hardness, gallium leaves strong blue-gray traces on paper. It preserves its lustre in a laboratory in which the air is always charged with acid vapours; it remains equally brilliant in boiling water; but it slowly tarnishes in aerated water. The metal in fusion is of a white akin to that of silver or tin. Prepared cold, from a potassium solution, by means of electrolysis, it crumbles when it is thrown into warm water, and allows bubbles of gas to escape. At ordinary temperature, chlorine attacks gallium energetically with great disengagement of heat; the action of bromine is less violent than that of chlorine; to obtain the iodide, it is necessary to heat slightly.

RESISTANCE OF THE AIR IN THE TORSION BALANCE.—Recent experiments on this subject by MM. Cornu and J. B. Baille lead to the law that, the resistance of the surrounding air to the motion of the index or lever of a torsion balance is proportional to the first power of the angular velocity of the index.

ACTION OF OZONE ON IODINE.—M. Ozier finds that the passage, or electric discharge through a tube containing oxygen and vapour of iodine, is attended by the formation of periodic acid as well as the lower oxides of iodine.

OXIDATION OF ALUMINIUM.—MM. Henze and Jehn, experimenting on the peculiar oxidisability of aluminium when rubbed with mercury or its salts, attribute the phenomenon to the formation of molecular galvanic elements with the aluminium, mercury, and moisture condensed upon them. When the metals are dry and in a dry atmosphere, there is no oxidation. Other electro-negative elements yield similar results; for example, aluminium in contact with moist platinum becomes covered with alumina. In this experiment, silver, tin, gas coke, &c., give the same deposit. It is curious that the alumina formed by these methods increases in amount after being rubbed. MM. Henze and Jehn explain this by supposing that the oxygen which was polarised during contact subsequently acts on the metal.

ON THE VARIATIONS OF TERRESTRIAL MAGNETISM.—M. Quet examines by the aid of the calculus, the direct action of the sun upon the magnetism and electricity of the earth. If we consider a hypothetical earth, properly constructed with regard to conductivity and magnetic capacity, turning upon its own axis and describing an orbit round a sun traversed by electric currents sufficiently intense to act with efficacy upon it. If we examine in turn all the effects of constant and variable forces, and apply the general principle of Laplace, that the state of a system of bodies becomes periodic, like the forces which actuate it, when the effect of the primitive conditions of movement have disappeared under the action of resistances. This fictitious earth will become magnetic; it will have its boreal magnetic pole north of the equator and the austral pole south of it. Its atmosphere will be charged with positive electricity, of which, the tension will increase with the height above the level of the ground. The layers of air next the ground will be electrified negatively. At the surface of this earth, compass needles will experience continual changes, both in the direction of the needle and in the intensity of the magnetic force upon it. These changes will follow

a daily variation, regulated by the solar hours. The direction of this daily variation will be contrary in the two hemispheres separated by the equator. The diurnal variation will be accompanied by an annual inequality. For this inequality the deviation of the compass will be in the same direction in the two hemispheres. There will be also an annual variation corresponding to the solar months. Perturbations on the needle will be observed if the solar currents vary in intensity. At the same instant of time the austral pole of the declination compass will suffer, over the whole earth, simultaneous but unequal deflections, great in some regions, small in others, here directed towards the east, there towards the west. If the state of the sun varies periodically, these perturbations will be correspondingly periodic. The magnetic needle would then serve to indicate electro-dynamic changes in the sun. The hypothetical earth that we have considered offers a striking image of what passes on our globe, and seems to increase the probability of the theory of direct solar action on terrestrial magnetism.—*Les Mondes*.

CANDLES ALTERED BY LONG EXPOSURE TO SEA-WATER.—Dr. J. H. Gladstone has published the results of a curious analysis which he recently made into the condition of some tallow candles forwarded to him by Mr. Latimer Clark, and recovered in 1875 from the wreck of a Dutch treasure ship sunk in Vigo Bay in 1702, that is 173 years before. The wick was found to have rotted away, but the tallow had become a heavy friable substance of a dull white colour, which, however, contained portions of fat apparently unchanged. The pure fat could easily be separated from the remainder by treating the candles with ether and benzine. On completely burning a candle there remained a strongly alkaline white ash, consisting of carbonate and chloride of calcium and sodium, with traces of magnesium and potassium. The fat had, in fact, been converted in great part into calcium and sodium salts, doubtless by the slow replacement of the triatomic group, C_3, H_5, in the stearine by three atoms of the metal, with the simultaneous production of glycerine. That this double decomposition has proceeded so slowly as to be only half completed at present, is, as Dr. Gladstone remarks, the most interesting point brought out.

THE "Harmonic Analyser," or machine for calculating the integral of the product of two given functions, which was invented and brought before the Royal Society by Sir William Thomson and his brother, Professor James Thomson, is to be employed in the Meteorological Office for tidal analysis.

NEW OBSERVATORIES IN FRANCE.—By a decree, of date March 11, three new astronomical and meteorological observatories, namely, one at Besançon, one at Bordeaux, and one at Lyons, have been fitted out in France. There are now eight astronomical observatories in that country.

NEW CRATER IN THE MOON.—Dr. H. J. Klein, of Köln, announces the appearance of a new crater on the Mare Vaporem, a little to the north-west of the well-known crater Hyginus. It is about three miles in diameter, gloomy and deep, with a ragged edge. The Mare Vaporum is situated near the middle of the visible surface of the moon. Dr. Klein has carefully examined this region for the last twelve years, and there is little or no room for doubt that a new crater has been formed on the lunar surface, bearing witness to the moon's actual volcanic activity.

City Notes.

Old Broad Street, July 15th, 1878.

THE report of the Eastern Telegraph Company shows that the Company's revenue for the six months ending March 31, amounted to £298,114. Deducting £58,101, the ordinary expenses of the concern, £26,179 special expenditure during the half year, £602 for bad debts, and £1,501 income tax, the sum available for dividend is £151,729, or adding the amount brought forward from the preceding half-year, £164,509. The Directors have, during the half-year, paid an interim quarterly dividend of $1\frac{1}{4}$ per cent. on the ordinary shares, and this with the dividend of 2s. 6d. per share now to be paid, will make a total of 5 per cent. on the ordinary shares, the dividend on the preference shares being at the rate of 6 per cent.

We do not know that the Revenue account calls for any special notice, though £26,000 is a large sum even for extraordinary expenses. Again, £602 for bad debts is a considerable item. In the balance sheet we notice that while the bills payable only amount to £1,184, the bills receivable approach £36,000, and the deposits and loans on security are £111,000. It is, of course, for the shareholders to inquire into the details of sums like these. The Joint Purse agreement recently established between the Indo-European and the Eastern Company is to be extended to the Indo-European Telegraph Department of Her Majesty's Indian Government, also we note the Company's system of cable is to be extended in the direction of Constantinople.

We are informed by the manager of the Direct Spanish Telegraph Company, Limited, that the rates to Portugal and Gibraltar by the company's Direct Spanish cable route have been considerably reduced. Thus, in future, a telegram of 20 words may now be sent from London to Portugal or Gibraltar for eight shillings, and from the country to Portugal for eight shillings and sixpence, or Gibraltar for nine shillings. Telegrams, if not written on the company's forms, should be directed *via* Spanish.

The following are the latest quotations of telegraphs: Anglo-American, Limited, $63\frac{3}{4}$-$64\frac{1}{4}$; Ditto, Preferred, $92\frac{1}{2}$-$93\frac{1}{2}$; Ditto, Deferred, 36-37; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, $6\frac{7}{8}$-$7\frac{1}{8}$; Cuba, Limited, $9\frac{1}{4}$-$9\frac{3}{4}$; Cuba, Limited, 10 per cent. Preference, 16-17; Direct Spanish, Limited, $1\frac{3}{4}$-$2\frac{1}{4}$; Direct Spanish, 10 per cent. Preference, $9\frac{1}{8}$-10; Direct United States Cable, Limited, 1877, $14\frac{1}{4}$-$14\frac{1}{2}$; Eastern, Limited, $7\frac{5}{8}$-$7\frac{7}{8}$; Eastern, 6 per cent. Debentures, repayable October 1883, 108-111; Eastern 5 per cent. Debentures, repayable August 1887, 103-105; Eastern 6 per cent. Preference, $11\frac{3}{4}$-12; Eastern Extension, Australasian and China, Limited, $7\frac{3}{4}$-8; Eastern Extension, 6 per cent. Debenture, repayable February,

1891, 108-111; German Union Telegraph and Trust, 8⅜-8⅝; Globe Telegraph and Trust, Limited, 5⅜-5⅞; Globe 6 per cent. Preference, 10⅞-11⅛; Great Northern, 8⅜-8⅝; Indo-European, Limited, 19½-20½; Mediterranean Extension, Limited; 2½-3; Mediterranean Extension, 8 per cent. Preference, 9¼-9¾; Reuter's Limited, 10-11; Submarine, 221-226; Submarine Scrip, 2-2¼; West India and Panama, Limited, 2⅜-2⅝; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited, 4¾-5; Ditto, 6 per cent. Debentures "A," 98-101; Ditto, ditto, ditto, "B," 96-99; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds, 116-120; Ditto, 6 per cent. Sterling Bonds, 101-103; Telegraph Construction and Maintenance, Limited, 31½-32½; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2¾-3; India-Rubber and Gutta-Percha and Telegraph Works, Limited, 27-28.

Railway shareholders can hardly be congratulated upon their prospects. As we intimated a little time ago, some of the dividends promise to be less than last half-year, and several will, no doubt, remain stationary. But it is not the dividends we are thinking of; we are thinking of the general condition of the companies, of their capital outlay, and of their increasing working expenses. It is possible that the leading journal, which has lately devoted much attention to the consideration of the question, exaggerates the gloominess of the outlook; but that it is sufficiently gloomy must be obvious to all impartial critics. In brief, is it not sheer folly to blink at the certainty that, if the companies go on increasing their capital, adding to their expenditure, and not sensibly adding to their income, the time will arrive, all too quickly, when even small dividends will be things of the past?

The Great Northern Company is already in difficulties. In spite of the positive tone assumed by the directors in the address they have recently issued to the shareholders, no one but the directors themselves—and perhaps not the directors—can deny that the anonymous circular they hold up to reprobation is written in a tone of marked moderation, and is sincerely intended to promote the interests of the shareholders. We believe that both it and other criticisms on the position and prospects of the Great Northern Company, which have lately appeared in print, are far more likely to do good than harm. The shareholders of the Great Northern Company have undoubtedly cause for apprehensions, and the assumption of the directors that it is presumptuous to comment on their actions, or to question their judgment, is simply ridiculous. There never was a period when railway companies wanted looking after more than they do at this juncture.

Look again at the East London Railway Company. One begins to wonder whether it has been managed by men or by children. The statements made in the circular issued by Sir Edward Watkin on his acceptance of the chairmanship more than account for the disastrous position of the company. No less than £3,404,595—the original capital was £1,866,600—has been actually expended by the concern. Here are some of the items:—Discounts, £540,691; financial agents' charges and commission, £192,517; interest on shares and debenture stocks, £337,015; preliminary expenses, £101,832—nearly £40,000 of this went to "the promoters;"—law and parliamentary expenses, £57,518; engineering, £66,981; directors and auditors, £16,222. Baron Grant on various occasions received from the directors altogether the sum of £333,306 for issuing debentures and preference stock. We do not say that the East London Company is past all hope, but if Sir Edward Watkin succeeds in rescuing the property, if property it can be called, from ruin, he will indeed earn the eternal gratitude of the shareholders, and convince every one that his abilities have really been under-estimated. It appears that part of the line is not worked at all, and produces, says Sir Edward, thistles and weeds instead of traffic and dividends. The Company is in debt beyond its available capital and resources to the extent of £120,000, and until this money is raised nothing can be done by the new Board. We have on several occasions drawn attention to the East London Company; but matters have turned out far worse than we supposed they could be. A searching inquiry into the details of the expenditure seems desirable, though it may be no practical use to cry over spilt milk. Mr. Kershaw might well say at the meeting of the shareholders of the company the other day that he wondered the old directors should face them again. At the meeting in question it was practically decided that Sir Edward Watkin, having the confidence of the shareholders, should be allowed to do what seemeth him best, and, to the surprise of some, it transpired that even some of the shareholders were willing to invest more of their money in the undertaking. Let us hope that their reward will be proportionate to their faith.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£ a	£	£	£	£ b	£	£	£	£	£	£ c	£ x	£
June, 1878 ...	41,480	11,124	300	793	12,840	31,118	23,269	18,582	... ...	10,350	 x	... ...	4,905
June, 1877 ...	40,040	9,843	3,295	873	15,260	45,477	24,126	19,663	... ...	9,960	4,025 2,225	10,522	5,541
†Total Inc. 1878	75,640	1,393	... ...	... ...	... ...	... ...	... ...	3,438	... ...	1,139	... ...	... ...	... ...
†Total Dec., 1878	... ...	... ...	881	666	6,370	26,327	3,718	... ...	... ...	... ...	... ...	... ...	2,147

a Amount accruing by arrangement with Direct Co. c Amount subject to arrangement with Anglo Co. † Compared with same period (six months) 1877. x June Receipts not yet to hand. c The May receipts of this Company amounted to £1,450.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).

THE TELEGRAPHIC JOURNAL.
Vol. VI.—No. 132.

THE TELEPHONE COMPANY AND THE NEW TELEGRAPH BILL.

A petition has been presented to Parliament by the Telephone Company of London, praying the House of Commons not to pass the New Telegraphs' Bill as it now stands, on the ground that it would confiscate the Company's property, and deprive the Bell Telephone patentees of the fruits of many years labour and study, and begging that the said Bill may be referred to a select committee who should examine the question at issue. This action has been taken by reason of Clause 3 in the New Telegraphs' Bill. By that clause it is proposed "that in the construction of the Telegraph Act of 1869, the term "telegraph" shall in addition to the meaning assigned to it by that Act, include any "apparatus for transmitting messages or other communications with the aid of electricity, magnetism, or any other like agency." It is clear that this clause covers the telephone, and the Telephone Company are reasonably afraid that the Government monopoly will appropriate their inventions and shut them out from their own use of it. In their own words they "apprehend that the introduction of the 3rd clause into the now pending Bill has been designedly done by the Post Office, for the express purpose of obtaining a monopoly of so much of the Company's business, as would be in competition with the Post Office Telegraphs," and "that the effect of the said Clause 3 would be to give the Postmaster-General not only the right of using the telephone, without payment of any compensation whatever to the owners of the patents, but also of prohibiting your petitioners from supplying telephone communication themselves." An arrangement between the Company and the Post Office at present exists whereby 60 per cent. of all rentals from postal telephone lines is handed over to the Company, and it is feared that Clause 3 will enable the Post Office to evade this royalty. In fine, the Telephone Company naturally fear that the Government monopoly will not only abolish all competition on their part, but likewise accord them insufficient compensation.

An annex to the petition sets forth the aims and scope of the Telephone Company, who at great expense have purchased Professor Bell's patent. "Telephonic lines," says this document, "might for instance be erected between the Temple, or the various Inns, and Westminster, for the benefit of barristers and solicitors frequenting the different Courts. These would be connected with a *central station*, say for instance, in the Strand, from which branch lines would diverge to the different chambers or offices. The whole would be the property of the Company, and the operation would be as follows:—A barrister at Westminster would come to the Telephone Office, and say he wished to speak with the clerk at his chambers. This information would be conveyed to the central station, where they would at once switch on the special branch wire connected with these chambers, and thus afford the parties the advantages of direct private verbal communication, without any loss of time." A similar plan is likely to be of great service to shipowners, merchants, manufacturers, and bankers, enabling them to communicate vocally with their agents at docks, wharves, or branch establishments; and as a household telegraph it would prove very accommodating. In the same way "different towns may be joined together," so runs the annex, "such as Manchester, Liverpool, Glasgow, and London. A Manchester merchant, for example, now requires to come to London to see some one on business. He consumes 10 hours, at least, in travelling, has to spend one night in town, and is at heavy expense, apart from the loss of valuable time. On the other hand he can arrange that he and his correspondent shall be at the Telephone Offices at a certain time, and thus settle their business by direct *viva voce* communication." These examples serve to show how wide the field for the telephone undoubtedly is, and how important and valuable it may become in the future.

While admitting that the Telephone Company have excellent grounds for the action they have taken, we will not go so far as to say that the offending clause has been specially levelled at them. It appears to us to have a more general bearing, and to be designed to correct the narrow phraseology of the old Act. We understand that Bill to limit its definition of "telegraph" to all instruments which make "signals"; doubtless because at the time it was drawn up, no one anticipated a telegraph which would act without some kind of signals. The invention of the speaking telephone has opened the eyes of our legislators. It is now seen that there may be modes of telegraphing without signals, and the old phraseology requires to be expanded so as to take in these, and provide for the future as well as the present. However, it must be confessed, that by the showing of the Telephone Company themselves, the telephone might become a formidable rival to the Government telegraphs. If long telephone lines ramify the country throughout its length and breadth, there will be a telegraph system within a system, each competing with the other, and a strict Government monopoly will no

longer exist. It is also conceivable that some new invention, now totally unexpected, might outstrip the existing complex systems, and leave their cumbersome paraphernalia stranded and obsolete on the shoals of telegraphic time. What then would become of the Government monopoly for which £10,000,000 were paid? Obviously it is prudent for the Postmaster-General to alter the wording of his charter, and stretch the old formula to meet not only the new facts, but the new possibilities. The vagueness of the altered language excites our admiration; "by aid of electricity, magnetism, or any other like agency," is a phrase whose comprehensive vagueness is worthy of Russian diplomacy.

It is satisfactory to know that the conflict between the Telephone Company and the Government is in a fair way of being settled. A deputation of members of Parliament, and others interested in the development of telegraphy, waited recently on the Postmaster-General, and conferred with him upon the subject. The Postmaster-General was understood to say, that the general question that had been raised by some speakers, as to whether it was or was not right that the Government should have a monopoly must be set aside, as that question had been determined by Parliament when the telegraphs were taken over by the Government. Dealing with the special case brought before him by the deputation, he disclaimed on the part of the Government any knowledge of the fact that a private Company had been formed when the Bill was introduced into Parliament, but held out the hope that a friendly conference of those interested in the matter with himself, might result in some modification of the existing clause.

In coming forward as they have done, the Telephone Company have not only asserted their rights, but rendered a service to the electrical profession in general. The obnoxious Clause 3 as it stands, is, as Mr. Sullivan pointed out to the Postmaster-General, a dangerous blow at telegraphic invention in this country. The Government have acquired a monopoly of the telegraphs which is on the whole a benefit to the public at large; but at the same time it should not be allowed to become an oppression to inventors. In the end it is for the public good that it should not become so. But what would an absolute monopoly over all possible telegraphs as claimed by the said clause be, but a despotism to inventors? Regarded superficially, it may seem a harmless thing, but like all rights in the grasp of power, it would soon prove high-handed. The English inventor who felt that there was only one purchaser for his invention in England—the Government monopoly—and that he must either take what it chooses to offer him, or want, would very soon cease to invent, and telegraphic invention would languish in this country even more than it does at present. Monopolies, even Government ones, carry in them the seeds of evil; but these seeds, by wise and careful management, may be prevented from germinating. It will now lie with the Postmaster-General to see that the New Telegraph Bill recognises the rights of inventors, and encourages their efforts by a prospect of fair remuneration.

THE INVENTION OF THE MICROPHONE.

THE *New York Daily Tribune* of June 27 contains the following reply of Mr. Edison to the joint telegram of Mr. W. H. Preece and Prof. Hughes categorically denying the piracy of invention which Mr. Edison imputed to them. This telegram was published in our issue for July 1, and it is necessary that we should give Mr. Edison's answer to it, and the proofs of his case.

To the Editor of the *Tribune:*

Sir,—In reply to the card of Messrs. Preece and Hughes, regarding the piracy by the latter of my carbon telephone, as contained in your paper of this date, allow me to refute their statements by their own words, and by extracts from the English scientific papers. I quote from their card:

"Hughes has not brought out any thermopile.
"W. H. PREECE."

"I emphatically indorse every word of the above message.
"D. E. HUGHES."

From *The Engineer*, May 17, 1878:

"Professor D. E. Hughes's telephone, microphone, and thermopile. . . . A discovery not made till after Professor Hughes's paper was read before the Royal Society, points out another field of usefulness for this instrument. We all know what excellent service the thermopile has done in the hands of Professor Tyndall and other investigators of heat, but we think we may safely describe another kind of thermopile, as sensitive and far less complicated, less difficult to construct, and less expensive than that compounded of zinc and antimony in the usual fashion. Instead of the glass tube as described, Professor Hughes was experimenting with a quill, and found that the instrument was exceedingly sensitive to heat. On the approach of a warm hand the galvanometer needle swings violently in one direction; on cooling the tube it swings in the other."

Again, I quote from an article on the telephone and phonograph from *The Washington Star*, April 19, 1878:

"My carbon telephone may be used as a heat measurer (thermopile). It will detect the 50,000th part of a degree Fahrenheit, &c."

This paper was mailed to Mr. Preece April 20, 1878, and I prove that he received it by quoting from the same article the following:

"The phonograph will preserve the exact pronunciation. The President of the Philological

Society means to travel with it amongst all the North American tribes."

To set at rest the claims of Hughes on this subject, I quote from a letter received by me a short time since from Professor Langley, the eminent astronomer:

"Allegheny Observatory, June 4, 1878.

"In response to your inquiry, I may state that to the best of my recollection, in October, 1877, at Gow Laboratory, Menlo Park, on my telling you that an instrument more sensitive to radiant heat than the bismuth-antimony-linear pile was desired by me for certain researches in the spectrum, you suggested the use of carbon, of which you were showing Professor Barker and myself specimens. As well as I remember the idea you gave me was that the common small thermopile was capable of developing little energy, the variation of resistance of the carbon under the influence of pressure or traction from a small heated adjacent body might be made to control the energy of a battery of any size, and thus multiply the sensitiveness of the pile almost without limit."

Mr. Preece, in his card, says:

"His (Hughes's) microphone is quite a different instrument to Edison's telephone."

Hughes, in his original paper of May 8, 1878, after summing up the labours of others, says:

"It will be seen, however, that in the experiments made by myself the diaphragm has been altogether discarded, resting as it does upon the changes produced by molecular action, and that the variations in the strengths of the current flowing are produced simply and solely by the direct effect of its sonorous vibrations."

I quote from the *Journal of the Telegraph*, April 16, 1878 (to which paper Mr. Preece is a subscriber) an article taken from the proof-sheets of Mr. Prescott's book on the telephone and phonograph, which reads as follows:

"In the latest form of transmitter which Mr. Edison has introduced the vibrating diaphragm is done away with altogether."

From this book which is now published, I quote from page 226:

"I (Edison) discovered that my principle, unlike all other devices for the transmission of speech, did not require any vibration of the diaphragm. That, in fact, sound waves could be transformed into electrical pulsations without the movement of any intervening mechanism."

This statement by myself for publication in Mr. Prescott's book was written over four months ago.

I quote from a letter from Preece to myself, date London, May 23rd, 1878:

"Hughes's doings border very closely upon yours, and it is difficult to distinguish between what you have done and what he has done."

Again, Mr. Hughes, after describing a number of experiments, sums up and says: "Carbon is used in preference to any other material. . . . It is quite evident that these effects are due to a difference of pressure at the different points of contact."

I quote from the *Journal of the Telegraph*, April 16, 1878:

"By constant experimenting, Mr. Edison at length made the discovery, that when properly prepared, carbon possessed the remarkable property of changing its resistance with pressure, and that the ratios of these changes, moreover corresponded exactly with the pressure."

The same discovery was published in the *Scientific American* of July 17, 1877, *Harper's Magazine*, and many other papers, both in this and other countries. I quote an extract from a letter addressed to Sir H. Thompson, the eminent surgeon, a copy of which was kindly sent me by the writer:

"Hotel Chatham, Paris, June 7, 1878.

"My dear Sir Henry,— . . . . It is certain that at the meeting of the British Association at Plymouth last September, a method of magnifying sound in an electric telephone was described as having been invented by Edison, which was identical in principle and in some details with that brought forward by Hughes.

(Signed) "WM. THOMSON."

Finally, Mr. Preece had ample knowledge, through my correspondence with him, of all I have been doing since he left America, and had my telephone in his possession at least a month before the alleged discovery by Hughes, and it is almost impossible to attribute his failure to defend me (as he was bound to do) against the piracy of Hughes, to his not understanding so simple an instrument, and the principle involved therein.

Mr. Preece says in his card of yesterday:

"I am in no way whatever a coadjutor of Hughes."

I quote from Hughes's original paper announcing his alleged discovery:

"My warmest thanks are due to Mr. W. H. Preece, electrician of the Post Office, for his appreciation of the importance of the facts I have stated, and for his kind council indeed in the preparation of this paper."

Enclosing this letter, allow me to mention that Mr. Hughes has addressed a communication to the French Academy of Sciences, in which he adds to his pirated telephone the induction coil which I have always used in combination therewith, and which alone makes it a practical instrument, thinking perhaps that under cover of foreign language, and before a society whose proceedings are not generally known in this country, he would gain for himself the credit of this combination. He makes no mention of this all-important factor in England, where it would be at once known, and in which country it has been patented nearly a year.

Yours truly,
THOMAS A. EDISON.

Menlo Park, N.J., June 26, 1878.

We have little desire to harp upon this most regrettable affair, but the above communication provokes a few remarks. To any person unacquainted with the true nature and phenomena of the two inventions, the carbon telephone and the microphone, Mr. Edison's proofs are perhaps fair and seeming, and we have no doubt that they will satisfy many readers of the daily newspaper in which they appear; but they are altogether too unsub-

stantial and superficial to weigh with scientific men. Mr. Edison presents his proofs as if the microphone were identical with the carbon telephone, whereas they are distinct instruments. The same general principle may underlie their action, but the principle appears under a new mode in each, and it is the microphone which has revealed this general principle, not the carbon telephone. But even if this were not so, the fact elicited by this controversy that the discovery of the variability of carbon resistance under pressure was anticipated by M. Clerac—and known to Professor Hughes—some ten years before Mr. Edison applied it, deals a fatal blow to the contention of the latter. The strongest point in Mr. Edison's reply is the extract from a letter of Sir W. Thomson to Sir Henry Thompson; but partial extracts are always unsatisfactory, and cannot be justly considered without their context. The "method of magnifying sound" referred to by Sir William, is, we suspect, our old friend the carbon telephone again, pure and simple; for by employing a sufficiently powerful battery and a suitable receiver, the energy of the voice or other sounds may be *magnified*. It is almost needless to point out, however, that a *magnifier* of sounds is not necessarily a microphone, since an instrument might obviously be constructed which would magnify audible sounds, but be utterly insensitive to inaudible sounds. Mere names and other "clothes" will not serve to cloak this matter. Mr. Edison's proofs lead us to infer either that he does not himself yet fully understand what the microphone really is, or that he wishes the American public, rightly or wrongly, to believe it to be a piracy of his carbon telephone. We much prefer to accept the former inference, and we think we can discover evidence of it in his reply. The importance given to the "thermopile," or "thermoscope," as it would be better named, by a contemporary, has apparently helped to mislead him into the belief that his authorship of the carbon telephone was endangered. It is time, however, that Mr. Edison should correct himself, and after the hot and hasty aspersions which he has launched upon the fair fame of two unoffending gentlemen, it will be to his own credit if he frankly acknowledges his mistake. Mr. Edison has many friends in England who admire his inventive abilites, as well as the independent manner in which he has risen, and who will feel sincere regret if he does not make that amends, and reinstate himself in their estimation.

AN IMPROVED MORSE INSTRUMENT.

The new Morse receiving instrument of MM. de Sussex and Brasseur, of Brussels, possesses some notable improvements over the older forms. In the ordinary Morse apparatus, as is well-known, the disc or blade, by which the marks are made upon a travelling strip of paper, is carried by a lever, which is fixed to the armature of an electro-magnet, the coils of which are connected to the line wire. The armature is ordinarily held apart from the magnet by a light spring; but when a current from the line wire passes through the coils of the magnet the armature is drawn towards the magnet, and the printing disc or blade is brought against the paper. In the new Morse the light spring is discarded, and in its stead a magnetic arrangement is substituted. This consists in placing on the opposite side of the armature, and near to it the ends of two soft iron cores, similar to the cores of the electro-magnet. The opposite ends of these cores are coupled together by a permanent horse-shoe magnet. This magnet, acting through the soft iron cores, attracts the armature and holds it away from the electro-magnet. The soft iron cores are surrounded by fine wire coils, similar to the coils of the electro-magnet, and the currents from the line wire are sent through all four coils—those above, and those under the armature. When a current passes from the lines through these bobbins the electro-magnet attracts the armature downwards while at the same time the poles of the upper coils are reversed, and repel the armature, which is feebly magnetic, downwards, thus assisting the electro-magnets. The resistance of the bobbins is so arranged as to give the maximum power for a given line.

Figures F and 2 represent a side and an end view of the essential parts of this apparatus.

A is the permanent magnet, the power of which can be increased or diminished by sliding across it the soft iron regulator R.

B and B′ are the upper and lower bobbins.

G is a frame of copper for supporting the cores of the two upper bobbins and the permanent magnet A.

T is a bar of soft iron supporting the lower pair of bobbins and connecting their cords.

P is the soft iron armature, feebly magnetic, for actuating the printing lever.

a, figure 2, is the south pole of the magnet A.

b, is the north pole of the magnet A.

a' is the south pole of the cores of the lower bobbins when a current is passing.

M is a portion of the brass frame of the instrument.

The current from the line O, passes to earth E, through the several wire coils to S, magnetises a^1 and b^1, a^1 becoming a south pole, and b^1 becoming a north pole. At the same time the poles a, b, of the permanent magnet are reversed, a becoming a north pole, and b a south pole.

The armature P, which always retains some residual magnetism, remains a north pole at the end b, and a south pole at the end a; and is, therefore, repelled at the change of polarity in the cores of the coils B^1, B^1, while being simultaneously attracted by the poles a^1 b^1 of the lower bobbins.

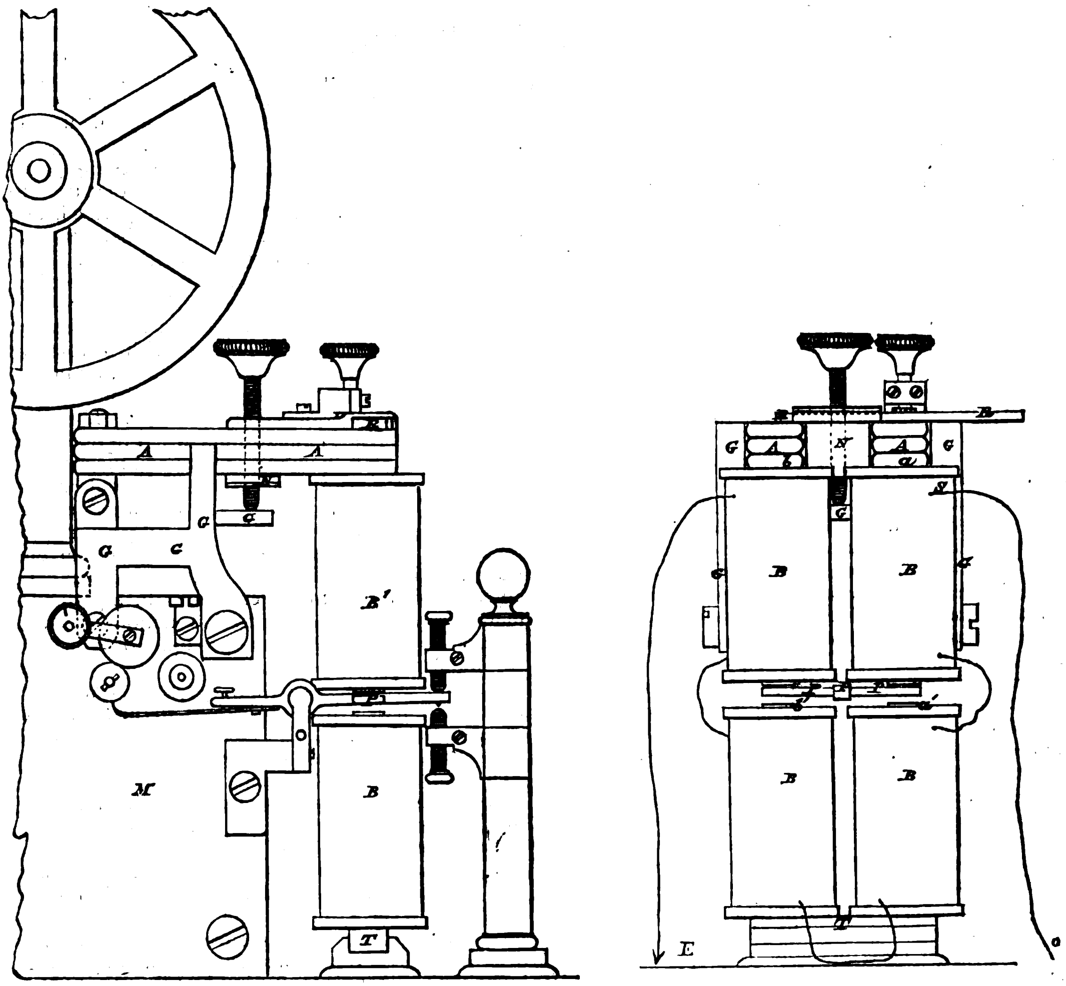
The main advantage of this form of construction is the increased sensitiveness of the armature to line currents; and MM. de Sussex and Brasseur also apply the same principle to relays for long lines. In fact, a Morse of this description is in itself an excellent relay when divorced from the marking parts.

Some idea of the sensitiveness of the instrument may be gathered from the information that correct signalling has been obtained from it by a small Leclanché cell, acting through 1,000 ohms resistance; and twenty-five Leclanché cells, each seven centimetres high, give correct marking through 30,000 ohms. It is also worthy of mention that a bare copper wire, a kilometre long, laid along the

grass of the Jardin Zoologique, Brussels, during a soaking wet day, transmitted enough of the currents from ten small Leclanché cells to work the instrument satisfactorily.

In addition to the unusual sensibility of the apparatus it is especially suitable for duplex working without the aid of condensers, on land lines of from four to five hundred miles. By winding the coils differentially, by the employment of a rheostat or artificial line of three graduated resistances, one for *dry*, another for *fair*, and a third for *foul* weather, were equivalent to a Hughes' Printer operating in simplex. The battery employed varied from ten to twenty Leclanché elements, according to the state of the weather.

A small portable field Morse of this kind is specially constructed for military purposes. It can be arranged for simplex, duplex, or the automatic recording of messages sent out from the home station. The experiment of the Jardin Zoologique would indicate the serviceableness of the apparatus for campaigns in which the insulation of lines is, as



and by means of the provision for adjusting the armature, duplex working is rendered successful without condensers.

For some time past this form of Morse instrument has been experimentally tried in duplex working on the Belgian Government telegraph line between Brussels and Liége, a length of 100 kilometres, and, as appears from the report of Mr. John Gibbs, the Chief-Inspector of the Service, it has given entire satisfaction. Two operators were employed at each end of the line, and the results a rule, very defective, and the currents available very weak. A patent for this apparatus, No. 3,639, 1877, has been taken out in England.

The Darien Canal.—**The contract for the cutting of this canal has been ratified and the work will proceed forthwith. It is specified that it be completed by the year 1895, and when open shall be neutral to the whole world. A strip of land, for its entire length, on each side of the canal, and 1,000,000 acres besides have been granted to the company by the government of Columbia.**

ELECTRIC TELEGRAPHY AT THE UNIVERSAL EXHIBITION OF 1878.

By M. LE COMTE DU MONCEL.

Continued from page 270.

THE instruments of MM. Baudot and Meyer, which we have described in our preceding articles, have found an imitator in the Austrian Exhibition. M. O. Schaeffer exhibits two extremely interesting instruments, which appear to be happy modifications of the above-named. We have not yet been able to study them sufficiently minutely to discover the exact points of resemblance between them and the French instruments; but the principle is evidently the same, and they are admirably constructed.

In the apparatus called by M. Schaeffer "Multiple Type-writing Telegraph," arranged for four transmissions, the motor system, which gives movement to the four instruments, is fixed in the centre of a large table, and the receivers are double Hughes' instruments. The manipulating keys are the ordinary Hughes' manuals, and the "combiners" are disposed in pairs, like the receivers. A first glance at these instruments shows that the author has made use of both directions of the current, so as to employ a smaller number of electro-magnetic parts; and instead of the 20 electro-magnets which, in M. Baudot's system, would have to be applied to the combiners for four simultaneous transmissions, M. Schaeffer uses but 10. There are, it is true, in addition, the four electro-magnets of the receiver and two others, which are applied to the motor mechanism, one of which is intended for the regulation of synchronism, as in the Meyer system. The discs of the combiners are insulated from each other and arranged in couples near each group of electro-magnets; and the production of impressions, instead of being effected by the combination of electric circuits, is determined mechanically by the action of engaged levers. The combiners themselves act under the influence of a general distributor, whose motion is synchronous with that of its correspondent, as in the Meyer apparatus; and the combinations of elementary signals intended to produce the different letters are effected by the mere depression of the manual keys, thus obviating the necessity of producing the combination by the fingers. This system is undoubtedly more convenient for those who are not accustomed to telegraphic manipulation; but for skilled employés transmission can be effected more rapidly by the Baudot system, since by having under the fingers the contacts necessary to produce any given signal, it is not necessary to search for them on a key-board, and so inconvenience the hand. As soon as we have a detailed description of this apparatus, we shall hasten to present it to our readers, as it seems to us to merit their attention equally with M. Baudot's, although it is but a derivation from the latter.

The instruments of MM. Baudot and Schaeffer naturally lead us to consider the other printing systems represented in the Exhibition, and among them we discern that of M. Olsen, which appears to us to be the most important after M. Hughes', which has always maintained the lead hitherto, and of which several specimens appear in the Exhibition.

PRINTING TELEGRAPH OF M. OLSEN.—Of all the improvements sought to be imported into the printing telegraph of M. Hughes, none have been so successfully combined as those which we see united in the printing telegraph of M. Olsen; not only can this apparatus transmit automatically, but it allows, by its mere arrangements of parts, a more rapid despatch of messages. The mechanical and electrical arrangements are, furthermore, quite distinct from M. Hughes', so that it may be regarded as quite an original invention. This instrument has been submitted to several months' test by the French Telegraph Administration, and has given much satisfaction; its performance under ordinary manipulation may be estimated at 14 per cent. superior to that of the Hughes, and, with the automatic system, 33 per cent., a result which is due to the fact that in consequence of the arrangement of the transmitting and printing parts, all the letters can be printed in an interval of time corresponding to three letter spaces, and that effective use may be made of the simultaneous depression of double letters for nine different combinations.

To produce this result M. Olsen causes the printing mechanism to act independently of that used to rotate the type-wheel and correcting wheel, and consequently these two different mechanisms are driven by two different trains of clockwork. That which drives the type-wheel is arranged almost like that of the Hughes, but the regularity of movement is obtained in a different way; and it is by means of a small centrifugal regulator, with a rotating friction brake, whose tension is regulated by means of a barrel, grasped more or less strongly, that uniformity and syncronism are obtained. The other mechanism has no regulator, but when in operation is connected with the above mentioned mechanism, which imparts to it the necessary regularity of action. Its office is to cause the axis which carries the printing and correcting cams to perform one revolution upon itself at each emission of current. Its play is determined by an electro-magnetic detent, which had to be combined in a particuler manner by reason of a double action which is exerted upon it by the electro-magnet of which we are about to speak.

In this system, to obtain the results we have alluded to, it has been necessary to make use of reverse currents, and the electro-magnet intended to operate the detent has had to be arranged in such manner, that while acting upon two different armatures, it could at all times effect the unlocking of the printing mechanism. This problem has been solved by means of two independent armatures, polarised by the action of a permanent magnet, and jointed so as to lie close, in their normal condition, to the extended pole of a straight electro-magnet. So long as no current passes in this electro-magnet, the armatures remain depressed; but when a current is transmitted, one or other of the armatures rises according to the direction of the current; and as over the armatures are two arms, acting as an anchor escapement to a shaft, which re-acts upon the detent, the latter releases the printing mechanism at each movement performed by the armatures. We shall now see how the armatures thus raised act upon the printing cam, and enable it to produce the impressions.

We know that in the ordinary Hughes' system, the correcting wheel possesses as many teeth as there are letters on the circumference of the type-

wheel, so that to obtain two successive letter impressions, it is necessary for the printing shaft to make at least one whole revolution. Now, for this revolution, is needed a time equal to that occupied by the contact maker of the transmitter in passing over four contacts. M. Olsen, thinking this time much to great, has sought to reduce it by one-half, by allowing two impressions to be recorded by the printing shaft instead of one; and to this end he has applied two printing cams to the shaft; but that these cams might act independently when required, by the position of the successive letters transmitted, he found it necessary to arrange the printing lever, upon which they impinge, so as to be capable of lateral displacement; and he also had to separate them one from the other, by a space equal to one-fifteenth of the periphery of the type-wheel. On the other hand, as in so short an interval the correcting cam could not exert its function upon a correcting wheel disposed in the ordinary way, M. Olsen has reduced, by one-half, the number of teeth upon the latter, so that an interval between two teeth instead of corresponding to one letter, as in the Hughes' System, corresponds to two letters, and the interval between the two cams on the printing shaft exactly corresponds to that between the teeth. To enable either of the cams to be brought into action at will, according to the letter to be printed, M. Olsen binds the fork of the printing lever by a small bridle fitted to the detent shaft of the printing mechanism, the fork itself being centred; and accordingly as the detent shaft turns to the right or left, that is to say, according to the direction of the current transmitted, it presents the tip of the fork to one or other of the cams, which then acts as in the ordinary Hughes. At the same time that this action is taking place, a level-wheel gearing turns a vertical shaft which carries the correcting cam, which is in form of a helix, and which effects the re-adjustment. It is this vertical shaft, furnished at its upper portion with a toothed sector very finely gearing into a wheel of the first clock-work, which connects the two motor mechanisms during the time of impression and correction. In order that the line may present equal charges of positive and negative, a small friction commutator is put in action by the two electro-magnet armatures, and sends into the line after the apparatus is set in action, currents which are contrary to those transmitted, and which are of longer or shorter duration accordingly as the signalling currents are in one or the other direction.

The transmitter, instead of being circular, as in the Hughes system, is longitudinal, and is placed underneath the apparatus, immediately behind the finger-keys. It is, in fact, a horizontal arbor, furnished with cams arranged so as to form a helix, and separated by spaces precisely corresponding to the spaces between the letters on the type-wheel; it is also driven by the same clock-work which drives the type-wheel; and the passage of the cams against contact pieces thrown out by the keys, furnishes at the required times the closing of the circuit necessary to the transmission of signals. As the currents sent out require to vary in direction for each successive letter, the electrical connection between the interruptors and the line is made in a reverse manner for each key, and in order that these combinations may adapt themselves to both sending and receiving, they are made to originate in a reversing commutator which is fixed on the back plate of the instrument and works automatically.

This disposition of the commutator is really very ingenious, for its movements are controlled without any effort on the part of the employé, and by the very operations which he is obliged to perform to set his instrument for sending or receiving. In fact, when sending he has to press down the "blank" pedal, and from the depression of this pedal results a movement of the commutator which places it in position for transmitting. On the other hand, to receive he has to press down the "blank" letter key, and from this alone the commutator changes its position.

All the other functions of the apparatus are performed as in the ordinary Hughes. Thus the change from letters to figures is produced by a special key placed on the key-board, as in the latter instrument; the zero or "blank" pedal acts in the same manner; and the unlocking of the motor apparatus is effected by means of a brake placed above it. The weights are tackled, also like the Hughes, and are wound up by a pedal and ratchet-wheel, but they are much less heavy. The apparatus is further provided with special contacts for duplex working.

As regards the mechanism for automatic transmission, it is very simple; it somewhat resembles the first Wheatstone automatic Morse system. The slip is perforated by means of a keyed perforator, similar to the transmitter; and the holes are ranged along two different lines, and are spaced in accordance with the distance between the letters of the type-wheel. The slip is drawn through a strong mill, put in motion by the same mechanism which turns the type-wheel, and the length of slip which runs through is calculated so that the length occupied by the different letters of the alphabet is unfolded in the time occupied by the type-wheel in performing one revolution. Two small bent points rest on the slip, and being supported by a double-jointed arrangement, are susceptible of two motions —1st, one which allows them to pass through the perforations; 2nd, a very slight longitudinal movement in the direction of the paper, which is made to control a circuit breaker. One of these points sends positive currents and the other negative, so that if the perforator has punched the holes in such manner that those on the left of the slip correspond to letters requiring negative currents, and those on the right to the other letters, transmission will be performed in an extremely simple manner; the complicated combination is entirely left to the perforator, which, being purely mechanical, can adapt itself without the employé having to do anything but press down the keys. With M. Olsen's apparatus this operation is performed as easily as the transmission of a message by the ordinary Hughes.

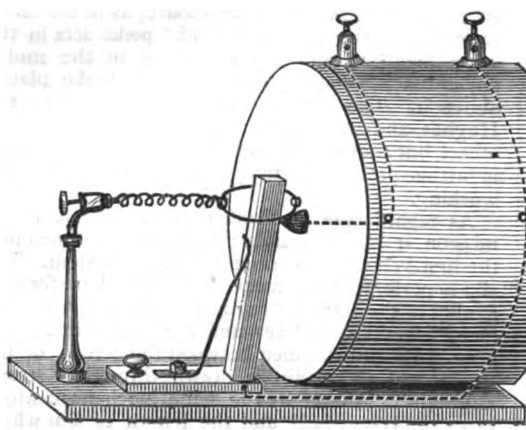
As we have said, besides the transmission of single letters, which can all be done with a spacing of three letter-intervals, it is possible to effect nine simultaneous transmissions of double letters, viz., blank and C, B and E, F and I, D and G, H and K, L and O, P and S, figure-blank and T, figure-blank and V, Z and A.

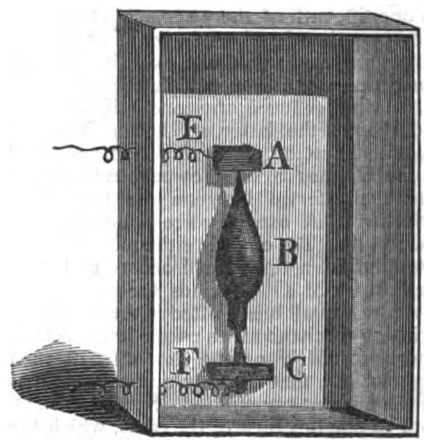
In spite of its delicate and complicated parts, this apparatus has been found to work well, and has been the admiration of all who have seen it working automatically in the Exhibition.

NEW MICROPHONES.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I have for some time thought that the true basis for a microphone for speaking was a tympanum-covered box, similar to those joined by a thread, and used as the so-called "Toy Telephone." These instruments speak clearly and audibly—the vibration of one tympanum vibrating the other at the opposite end of the string, and reproducing the sounds which influenced it. I therefore argued, that if all conditions were equalized, and a Hughes's Microphone, or carbon "wave-producing" arrangement, were placed in connection with the surface of the parchment tympanum, it should communicate as clearly through a distant Bell Telephone, and at the same time proportionately louder.





This I have found to be so, and have designed a form of microphone—quite novel, I believe—of which I send you a sketch. It gives results that will, I think, amply repay the extra trouble of its manufacture, reproducing in a distant Bell Telephone *every word* PERFECTLY UNMISTAKABLE, and CONSIDERABLY louder than originally spoken to it.

The above sketch needs little description. On the centre of the outer surface of the tympanum is fastened (with gum) a small triangular bit of "pencil graphite," having a fine wire attached to the circuit. Immediately above this a small ring is fastened through the tympanum to a very small shield at the back, and to the ring is attached a small spiral spring, or better, a fine india-rubber band, with screw adjustment (as shown), in order to obtain the forward tension on the tympanum (as produced by the "sag" of the thread in the "Toy Telephone"). The upright carbon—which is of the ordinary gas graphite, cut to a knife edge on the inside—is hinged to a slide below, which gives a power of adjusting it, and is kept pressed slightly against the pencil graphite edge by a very light steel spring, which (as shown) is also adjustable. This is of course designed solely for speaking, in which a considerable stability, combined with great elasticity, both in tension and pressure, are required. For very delicate experiments I have designed a form (of which I also send you a sketch, should you think it worth inserting), in which both friction and contact are reduced to an absolute minimum. This, when vertical and nicely balanced, is *wonderfully* sensitive—not only the noise of the fly *walking*, but that of his touching a pane of glass with his tongue, or sucking a grain of sugar—is DISTINCTLY *audible* in the telephone.

Yours, &c.,

A. M. VEREKER.

In the figure representing microphone for delicate experiments, A, is the upper support of gas graphite; B, peg-top shaped vibrator of same; C, wooden block through which D slides for adjustment; D, a pencil graphite point on which B rests; E, F, wires to battery and telephone. Both drawings are made half full size.

A PERMANENT photographic portrait of Dr. WERNER SIEMENS is in preparation for this Journal, and will be issued, with biographical sketch, with the Number of August 15th.

THE same and following issues will also contain a specially written notice of the British Association Meeting at Dublin.

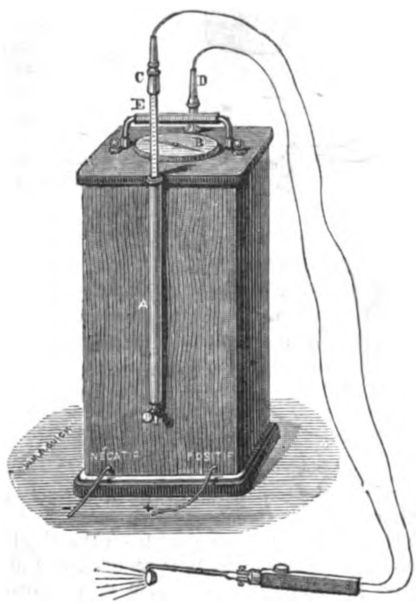
IT is rumoured that an invention or discovery more wonderful than any of those which have of late astonished the scientific world is about to be brought before the public.

THE POLYSCOPE.

M. TROUVÉ has recently presented to the *Societé de Physique* a new apparatus, named the Polyscope, designed to illuminate the cavities of the human body, the interior of mines, powder mills and magazines, the depths of the sea, &c. This apparatus is based upon the property which a voltaic current possesses of disengaging heat in a circuit of small section, and of which Dr. Joule, of Manchester, has given the following law :—

The quantity of heat disengaged in unit time in a homogeneous metal wire traversed by a voltaic current is proportional 1st *to the resistance that the wire opposes to the passage of the electricity, and,* 2nd, *to the square of the intensity of the currents.*

This property of the voltaic current of white-heating metallic conductors in traversing them, has been utilised in chirurgery by John Marschall about 1851, by Leroy d'Etioles in 1853, Mideldorpf in 1854, and Broca in 1856, &c. It was only at a later



time that lighting was aimed at. In 1867, Doctor Bruck, a dentist at Breslau, presented an apparatus designed to light the buccal (cheek) cavities, to which he gave the name of Stomatoscope. A little later in France, Doctor Millot made numerous experiments for to light the stomachs of animals at the Ecole Pratique, Paris. Success did not crown these attempts because of the inconstancy of the electric source which consisted of Grove and Bunsen cells, and required then to have very thick platinum wires to avoid exposing them to a permanent volatilization. Good luminous effects were obtained, but they were accompanied by heating effects too intense for the practical application of the method. Recourse was had to a circulation of water to annihilate the heat in proportion to its production, but the apparatus then became too voluminous and difficult of management for practical use. M. Trouvé, convinced of the practical importance of such a system of lighting, has devoted himself constantly to the subject since 1870. These researches have been completely successful, and the success is due, as he himself has admitted, to his judicious selection of the secondary battery of M. Gaston Planté.

The apparatus of M. Trouvé is composed of a reservoir A, or electric store, consisting of a Planté secondary battery, with an arrangement for regulating at will the flow of the current from it, by means of a special rheostat A, C, of great simplicity, and by the addition of a galvanometer B, with two circuits, in which the electromotive force of the reservoir, and that of the Trouvé-Callaud battery, intended to charge it, are opposed. Thanks to the ingenious combination of these instruments, the practitioner can always regulate at will the flow of the current, and know always by the galvanometer the state of the charge in the secondary battery. We have used the word flow, for those of our readers who are familiar with the secondary battery, know that it can be completely assimilated to a hydrostatic reservoir. The rheostat on the secondary battery, plays the same part as the hydrostatic reservoir; both moderate at will the flow of the current from the reservoir. This regularity is so great, that the apparatus of M. Trouvé, permits of raising to the point of fusion, without going beyond it during several consecutive hours, fine platinum wires of from $\frac{1}{15}$ of a millimetre, to $1\frac{1}{2}$ millimetres in diameter. The constancy of the electromotive force of the secondary battery, and the adjustable rheostat renders it possible to accurately determine once for all the point of fusion of wires of given thickness. Instead of employing a small spiral of the platinum wire as a wick, M. Trouvé ingeniously flattens the wire in the middle so as to obtain a little glowing disc for his illuminator. The substitution of this disc for the ordinary platinum spiral gives a lighting power sensibly doubled, as proved by Captain Manceron, in his experiments on lighting the interior of cannons at Saint Thomas d'Aquin. That distinguished officer has been able, with the polyscope, not only to light up the interior of cannons and shells, but also to obtain projections of them. In this way he shows upon a screen the smallest defect in pieces of artillery.

The lower part of the figure is the small reflector, spherical-concave or parabolic. It may be furnished with a diminutive folding mirror on its upper edge to direct the beam of light from the platinum disc, as may be desired. It is fitted with a handle, and wires connecting it to the reservoir. Instead of the reflector shown, a variety of cauteries, either pointed or knife-edged, may be inserted into this handle, and reflectors for special purposes, such as that used by dentists for inserting into the mouth to examine the gums.—*La Nature*.

In connexion with this subject we may mention that Mr. Edison proposes to enclose a tiny electric light in a glass bolus, small enough to be swallowed, for the purpose of illuminating the stomach, and exhibiting the process of digestion.

EDISON'S MICRO-TASIMETER.*

THE latest of Edison's inventions, and perhaps the most interesting to physicists, is his micro-tasimeter, or measurer of infinitesimal pressure.

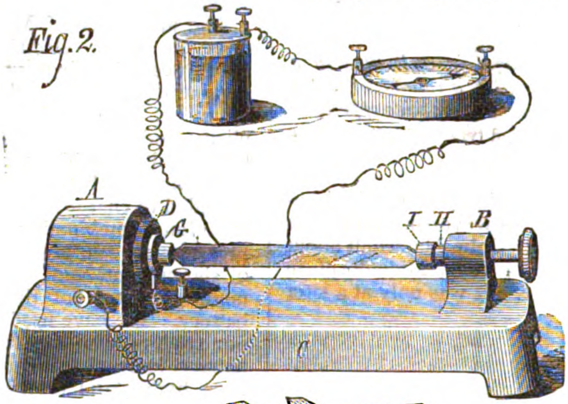
The thermopile, hitherto foremost among delicate indicators of changes of temperature, must now be consigned to the rear ranks, and the radiometer, which exhibits the motive power of the most subtile of forces, must retire in favour of an instrument that can weigh that force.

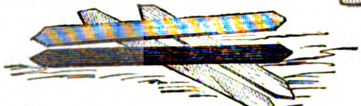
The micro-tasimeter is the outcome of Professor Edison's experiments with his carbon telephone. Having experimented with diaphragms of various thicknesses, he ascertained that the best results were secured by using the thicker diaphragms. At this stage he experienced a new difficulty. So sensitive was the carbon button to the changes of condition, that the expansion of the rubber telephone handle rendered the instrument inarticulate, and finally inoperative. Iron handles were substituted with a similar result, but with the additional feature of musical and creaky tones distinctly audible in the receiving instrument. These sounds Professor Edison attributes to the movement of the molecules of iron among themselves during expansion. He calls them "molecular music." To avoid these disturbances in the telephone, the handle was dispensed with; but it had done a great service in revealing the extreme sensitiveness of the carbon button, and this discovery opened the way for the invention of this new and wonderful instrument.

The micro-tasimeter is represented in perspective in fig. 2, in section in fig. 3, and the plan upon which it is arranged in the electric circuit is shown in fig. 4.

The instrument consists essentially in a rigid iron frame for holding the carbon button, which is placed between two platinum surfaces, one of which is fixed and the other moveable, and in a device for holding the object to be tested, so that the pressure resulting from the expansion of the object acts upon the carbon button.

Fig. 2.





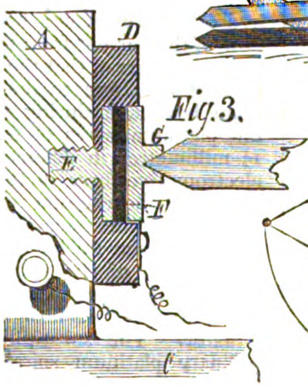
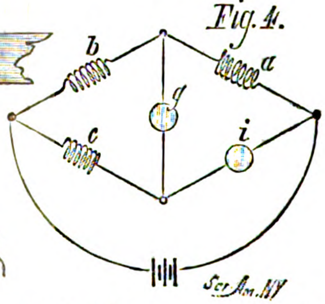


Fig. 3.

Fig. 4.



Two stout posts A, B, project from the rigid base piece, C. A vulcanite disc D, is secured to the post A, by the platinum-headed screw E, the head of which rests in the bottom of a shallow circular cavity in the centre of the disc. In this cavity, and in contact with the head of the screw E, the carbon button F, is placed. Upon the outer face of the button there is a disc of platinum foil, which is in electrical communication with the battery. A metallic cup G, is placed in contact with the platinum disc to receive one end of the strip of whatever material is employed to operate the instrument.

The post B, is about four inches from the post A, and contains a screw-acted follower H, that carries a cup I, between which and the cup G, is placed a strip of any substance whose expansibility it is desired to exhibit. The post A, is in electrical communication with a galvanometer, and the galvanometer is connected with the battery. The

* We are indebted to Mr. Edison for the blocks wherewith to illustrate this article.

strip of the substance to be tested is put under a small initial pressure, which deflects the galvanometer needle a few degrees from the needle point. When the needle comes to rest, its position is noted. The slightest subsequent expansion or contraction of the strip will be indicated by the movement of the galvanometer needle. A thin strip of hard rubber, placed in the instrument, exhibits extreme sensitiveness, being expanded by heat from the hand, so as to move through several degrees the needle of a very ordinary galvanometer, which is not affected in the slightest degree by a thermopile facing and near a red hot iron. The hand, in this experiment, is held a few inches from the rubber strip. A strip of mica is sensibly affected by the heat of the hand, and a strip of gelatin, placed in the instrument, is instantly expanded by moisture from a dampened piece of paper held two or three inches away.

For these experiments the instrument is arranged as in fig 2, but for more delicate operations it is connected with a Thomson's reflecting galvanometer, and the current is regulated by a Wheatstone's bridge and a rheostat, so that the resistance on both sides of the galvanometer is equal, and the light-pencil from the reflector falls on 0° of the scale. The principle of this arrangement is illustrated by the diagram, fig. 4. Here the galvanometer is at *g*, and the instrument which is at *i* is adjusted, say, for example, to ten ohms resistance. At *a*, *b*, and *c*, the resistance is the same. An increase or diminution of the pressure on the carbon button by an infinitesimal expansion or contraction of the substance under test is indicated on the scale of the galvanometer.

The carbon button may be compared to a valve, for, when it is compressed in the slightest degree, its electrical conductivity is increased, and when it is allowed to expand it partly loses its conducting power.

The heat from the hand, held 6 or 8 inches from a strip of vulcanite placed in the instrument—when arranged as last described—is sufficient to deflect the galvanometer mirror so as to throw the light-beam completely off the scale. A cold body placed near the vulcanite strip will carry the light-beam in the opposite direction.

Pressure that is inappreciable and undiscoverable by other means is distinctly indicated by this instrument.

Professor Edison proposes to make application of the principle of this instrument to numberless purposes, among which are delicate thermometers, barometers, and hygrometers. He expects to indicate the heat of the stars, and to weigh the light of the sun.—*Scientific American*, June 22.

SOME ELECTRICAL EXPERIMENTS WITH CRYSTALLINE SELENIUM.

By ROBERT SABINE.

THE experiments were undertaken with a view of removing, if possible, some of the difficulties which had been found in the way of constructing constant resistances of crystalline selenium.

The experiments were made with several specimens of annealed selenium, some of which were provided, when in the amorphous state, with platinum wires. The selenium was made in the form of plates about 0·1 centim. thick, 0·5 to 1 centim. broad, and 2 to 3 centims. long, wires (when employed) being inserted transversely at equal distances apart. In some specimens, the wires were laid upon a small piece of mica or platinum-foil, and the melted selenium dropped upon them; in others the platinum wires were heated to incandescence in a smokeless flame, and, while still hot, were imbedded in the amorphous selenium. The two methods appeared to be capable of giving equally firm contact, which was probably due chiefly to the contraction of the selenium round the platinum wire.

In preparing the selenium plates, care was taken to obtain as good a surface as possible, by melting the amorphous selenium between edge strips of glass upon a piece of bright platinum foil, upon which it was annealed.

The resistance of the junctions between the selenium and the platinum wires imbedded in it was found to be very various, but not to depend upon the manner in which the wires were imbedded in the selenium previous to its being crystallized. It was also found that the conducting-power of the selenium differed materially in different parts of the same plate.

A plate of selenium annealed at 170° C. was provided with four platinum wires, imbedded in it at different points, 0·5 centim. apart. The resistances were measured with + and — currents, and the means assumed to be sufficiently near for the purpose.

Between wires.	Measured resistances.
1 and 2	31 megohms.
2 „ 3	162 „
3 „ 4	11 „
1 „ 3	174 „
2 „ 4	172 „

From these measurements, by the well known formula, the separate calculated resistances are:—

Junction number.	Resistance of junction.	Resistance of selenium between junctions.
2 . . .	9·5 megohms	152 meghoms.
3 . . .	0·5 megohm	

This is an instance of high selenium resistance in the middle and low resistance towards the ends in an otherwise apparently homogeneous plate, and of low junction resistances. The two junctions were made at the same time, in the same manner, by melting the selenium upon the wires; and yet one of them has nearly twenty times the resistance of the other.

A second plate of selenium, provided with six platinum wires and annealed at 150° C., was measured with + and — currents in the same way, mean values being taken. This gave the following results:—

Junction number.	Resistance of junction.	Resistance of seleninm between junctions.
2 . . .	429 megohms	
3 . . .	479 „	22 megohms.
4 . . .	498 „	13 „
5 . . .	428 „	0 „

In this plate, therefore, nearly all the resistance

was situated in the junctions, whilst the selenium offered a comparatively small resistance, its conducting-power being much greater at one end than at the other.

A third plate was provided with seven platinum wires 0·7 centim. apart, annealed at 205° C. It showed electrically more homogeneity of material and quality of junction resistances.

Junction number.	Resistance of junction.	Resistance of selenium between junctions.
2 . .	·0333 meghom	0·1914 megohm
3 . .	·0553 „	0·1045 „
4 . .	·0328 „	0·1233 „
5 . .	·0199 „	0·1084 „
6 . .	·0285 „	

It is clear from these measurements that a large portion of the observed resistance of a so-called selenium resistance may, and frequently does, reside in the junctions and not in the selenium. Therefore the larger we make the service of contact between the platinum and the selenium, the less likely are we to find an otherwise sensitive piece of selenium rendered comparatively insensitive by the introduction of high junction resistance. In this respect the form of selenium plate designed by Dr. Werner Siemens, in which the platinum wires form gratings or interlying spirals, is unquestionably the best form to employ when the object in view is to obtain a high sensitiveness to light.

The author next describes some experiments by which he shows that the resistances of junctions and selenium are both affected by variations of *temperature* in nearly an equal ratio.

Resistance of Selenium altered by the inversion of the Current.

The fact that the current strength in the circuit of a bar of selenium and a battery is subject to change when the direction of the current is reversed has been pointed out by Professor Adams and Mr. Day. The inquiry naturally occurs whether the seat of the change is in the selenium or at the juuctions. To determine this, it is only necessary to ascertain the resistance of the junctions and of the selenium separately with two different battery powers to find which agrees best in the two measurements.

A plate of selenium, with four wires, *a*, *b*, *c*, and *d*, imbedded in it, was inserted in a Wheatstone bridge with an intervening commutator, so that the selenium could be inverted whilst the other members of the bridge remain unaltered. The side of the bridge containing the selenium was also furnished with a reflecting galvanometer of comparatively low resistance, by means of which the current moving in that side could, within a very small percentage of error, be observed. The battery-circuit was provided with a sliding resistance, by means of which, whichever section of the selenium plate was in circuit, the current in it, as indicated by the galvanometer, could be kept at a constant value. In this way the following measurements were made :—In the first series the current strength in the selenium was kept uniformly at 2·9 microwebers, and in the second at 0·42 microweber. The positions of the selenium are indicated as "direct" and "inverted."

Resistance measured between	Current = 2·9 microw.		Current = 0·42 microw.	
	Direct. meg.	Inverted. meg.	Direct. meg.	Inverted. meg.
a and *b*	·3176	·3181	·3202	·3244
b „ *c*	·3864	·3858	·3936	·3893
c „ *d*	·2734	·2734	·2747	·2782
a „ *c*	·6095	·6097	·6116	·6116
b „ *d*	·4842	·4846	·4906	·4900

Call the resistance of the selenium betwen *b* and *c* $\left\{\begin{matrix} s \\ s' \end{matrix}\right\}$ when the current is $\left\{\begin{matrix} \text{direct} \\ \text{inverted} \end{matrix}\right\}$; the resistance of the junctions $\left\{\begin{matrix} b \text{ and } c \\ b' \text{ and } c' \end{matrix}\right\}$ when the current is $\left\{\begin{matrix} \text{direct} \\ \text{inverted} \end{matrix}\right\}$; the resistance from *a* up to *b* $\left\{\begin{matrix} a \text{ ...... direct} \\ a' \text{ ...... inverted} \end{matrix}\right\}$; and, lastly, the resistance from the junction *c* to the end *d* $\left\{\begin{matrix} d \text{ ...... direct} \\ d' \text{ ...... inverted} \end{matrix}\right\}$.

It is evident that by measuring the resistance between each of the wires *a*, *b*, *c*, and *d*, in turn, with two different current strengths, we have data which enable us to calculate the mean resistances of the junctions as well as that of the selenium. If, with the two different current strengths, the calculated values of the junctions agree, we may assume that the change resides in the selenium ; on the other hand, if the selenium agrees in both calculations the change must reside in the junctions.

The above tests furnish the following results :—

Resistance of	Measured.	Current = 2·9 microw.	Current = 0·42 microw.
		meg.	meg.
$b + b'$	direct	·0945	·1022
	inverted	·0942	·1021
$c + c'$	direct	·1756	·1777
	inverted	·1746	·1775
$s + s'$	....	·5028	·5032

The agreement is in favour of the selenium, the mean resistance of which does not appear to change by decreasing the current strength : the mean resistances of the junctions, however, increased, one of them considerably ; and it is therefore probable that in them, and not in the selenium, lies the change in question.

(To be continued.)

Notes.

THE TELEPHONE.—Professor Dolbear has recently shown how nearly Reiss came to inventing a true speaking telephone. A drop of water inserted between the diaphragm and spring make and break contacts of Reiss' 1861 telephone, transforms it into a speaking telephone similar to Elisha Gray's. Professor Dolbear constructs a serviceable "water telephone" without the use of electro-magnetism, by using two parallel metal diaphragms fixed to a wooden ring, and forming a shallow box. The interior of this box, or space between the diaphragms, is filled with water. A battery is connected up to one diaphragm, and the other is

connected to line, so that the current passes through the water, the sound waves impinging on one diaphragm oscillate the resistance of the water, and a vibratory current is transmitted. If the speaking diaphragm be of iron, and the other of zinc, a feeble current is generated in the telephone itself. This telephone only acts as a transmitter as at present constructed.

M. SCHNEEBELI is engaged in causing a telephone, uttering a continuous note, to illustrate the formation of the vowels and consonants by varying the vent in front of the diaphragm. A tuning-fork is caused to interrupt the primary wire of an induction coil, while the secondary is in circuit with a telephone. By this means a loud note is obtained from the telephone. If then the mouth of the telephone be closed by the hand the vowels *u o* and *a* are easily imitated by varying the opening between the forefinger and thumb. The consonants may also be imitated. For instance, *b* is fairly reproduced by smacking the palm of the hand against the orifice of the telephone.

IT is reported that Mr. Edison has so far perfected his carbon telephone, that words spoken 100 feet from the transmitting telephone could be distinctly heard in the receiver, the length of the line in this case being only 30 rods.

THE Bell telephone was employed at the Wimbledon Camp, under the direction of Mr. T. Fletcher, electrician to the Telephone Company, in communicating between the marksmen and targets.

THE MICROPHONE.—M. Michel-Etienne de Rossi, of Rome, writes to *La Nature*, suggesting the application of the microphone as a means of detecting the subterranean rumbling sound, or *rombo*, which always accompanies and often precedes an earthquake, thus serving as a forewarner of the shock. A special microphone might also be employed as a micro-seismograph. *Apropos* of this subject, it has occurred to us that the microphone might be advantageously employed in observations on the quiesence of volcanoes. Cannot Professor Palmieri find a use for it at Vesuvius? Microphones properly placed in the crater and connected to a telephone would advertise a disturbance to any distance.

M. GAIFFE, constructs a special microphone by abutting a horizontal cylinder of carbon against the side of an upright plate of carbon so that about half of the thickness of the cylinder is in contact with the top of the plate. The cylinder is supported on a vertical stem on which it can slide up or down so as to adjust the contact.

THE PHONOGRAPH.—Mr. W. H. Preece has received an interesting communication from Dr. Clarence Blake, of Boston, on the diaphragm of the phonograph. It has been suggested in England that a phonograph diaphragm, shaped like the drum membrane of the human ear, might give improved phonographic utterance. Dr. Blake was led to the same conclusion from finding that flat discs gave too great a prominence to certain heavier overtones of the voice, to which they respond, and hence falsified the *timbre* of the voice in reproducing it. By forming the phonograph diaphragm into a flat trumpet-shape (with a funnel section), and fixing the embossing style into the cusp, it was found that the lighter over-tones were faithfully reproduced by it, while the sharper exaggerated over-tones recorded by the flat disc were cut off. When the embossing, as well as the reproducing, was done by this curved membrane, the sharper over-tones disappeared, and the quality of the voice was much more natural. Moreover, there was a gain in sensitiveness; the embossing could be done at a distance of 15 feet from the speaker, and clearly reproduced. The material of these membranes may be either stout felted paper, varnished on its outer surface, or drum-vellum, moistened and modelled into shape before using. "The principle governing the vibrations of such a disc," says Dr. Blake, "is that of imparting the vibrations to the centre of a membrane, the curve of which enables it to reproduce a large range of over-tones, its tension serving as a counter-balance to the central pressure." Dr. Blake has also found that the groove in the phonograph cylinder when covered with tinfoil, became a resonator for the high scratching noise of the embossing point and materially interfered with the reproduction of the quality of the voice. By stretching a thin layer of rubber-tissue over the cylinder this resonating effect was abolished, and the scratching noise materially lessened.

IN France and Germany it is proposed to make the "phonograph" a feminine noun, because of its propensity for talking back.

THE French Jury were uncertain whether to consign the phonograph to Class 15, Instruments of Precision, or Class 65, Telegraphic Instruments, in the Paris Exhibition, but they finally relegated it to the latter, on the consideration that it can serve as a recorder of telephone messages.

A PHONOGRAPH message was recently sent by Edison's telephone from the Paris Exhibition to Versailles, in presence of several *savants*.

JULES JAMIN ON THE ELECTRIC LIGHT.—We make the following notes from M. Jamin's recent discourse on lighting by electricity:

The brilliancy of the electric arc is equal, if not superior, to that of the sun—the latter being a star already old, and partially cooled.

Opalescent glass globes, by diffusing the light, reduce

its lustre to a degree proportionate to their surface, but waste a little light by absorption.

When alternative currents succeed each other at intervals of one-twenty-fifth of a second, the effect is that of a continuous light.

Jablochkoff, by introducing his condensers in circuit, is enabled to double the number of lamps fed from the same machine, the light of each lamp being, however, reduced one-half, *i.e.*, to 25 carcel burners. Flames of oil and gas are rich in the less refrangible colours, red and yellow, but poor in the more refrangible colours, blue and violet. It is impossible to supply the latter, hence the inferiority of such lights for illumination. The light from the glowing carbon points in the electric arc is white like sunlight, and has a similar spectrum: that from the arc itself, however, is rich in the more refrangible rays, hence its bluish tinge. This defect can be removed artificially, however, for sulphate of quinine or uranium glass transform the more refrangible rays into white light.

The humming given out by the arc produced by alternating currents, and even feebly by continuous currents, is a slight drawback to the electric light.

The Lontin Company, Paris, furnish all apparatus and materials for the light, but retain the ownership of them, and charge 50 centimes per hour for a light equivalent to 100 gas jets, on being guaranteed the requirement of a certain number of years. A merchant of the Louvre states that Jablochkoff's candle gives him more light at 30 per cent. less cost.

A diffused and uniform light, carefully kept in by closed apertures and shutters, is to be aimed at in electric illumination. At present, in street lighting by electricity, half the light is lost in the sky overhead instead of being reflected on to the pavements.

THE CHELSEA VESTRY have deputed their surveyor to report fully upon the subject of the electric light as a substitute for gas, and authorised him to proceed to Paris to study it there.

IT is not unlikely that the electric light will abolish the practice of rouging the cheeks, so common amongst the ladies of Paris. White and red paint is exhibited in all its garishness by the pure white beams of Jablochkoff, and the spurious beauties of the boulevards in all their borrowed plumes are pitilessly exposed.

AN electric light for navigating purposes has been tested on the Ohio River, U. S. A head-light illuminated the entire river some distance ahead, while four other lights were placed so as to light the cabin and deck.

THE Dundee Town Council have under consideration a proposal to light the town by electricity, the motive power being derived from the "Reekie Linn," a waterfall in the neighbourhood.

IN addition to the Place and Avenue de l'Opera, and the Louvre, the Jablochkoff light is now regularly installed in the Magasins du *Bon Marché*, the Salle du Chatelet, the Hippodrome, Cours-la-Reine, &c., &c., Paris. M. Grenet has successfully exhibited for over a month at the *Hotel des Deux-Mondes*, Rue d'Antin, an electric light supplied by battery power. A new light, by M. Delaporte, is also announced.

THE ELECTRIC LIGHT IN AMERICA.—The Cleveland (Ohio) *Herald* lately witnessed a trial of the electric light at the establishment of the Union Steel Screw Company, in that city. The apparatus used has been constructed for the illumination of a large carpet mill in Philadelphia. It consists of a Brush dynamo-electric machine of 12,000 candle power, arranged to give four separate currents, each running an electric lamp of 3000 candle power. Two of the lamps were placed on the third floor, and two on the fourth floor of the immense building, and when the engine was started up the machine started at the same time, and, without the slighest manual interference, the lamps flashed out their light in all its magnificence. The effect was most brilliant. The rooms were flooded with a pure white light, like the light of the sun, and it streamed out at all the windows, illuminating houses and streets for a long distance in every direction. The light was very uniform and steady, free from the flickering that used to be an accompaniment of electric light, and, considering the enormous illuminating power, the light was unexpectedly soft and endurable to the eyes. An opportunity was afforded to test the character and whiteness of the light. Worsteds, scarfs, afghans, &c., of brilliant shades, were hanging against the wall at one side of the room, and it was noticed that the colours were brought out as clearly as by the full light of the sun. Estimates were made as to the amount that the light furnished by this apparatus would cost, if used by the Screw Company as it was used on this occasion, and it was ascertained that the total cost of the whole light from the four lamps, including the items of consumption of carbon in the lamps, interest on the investment, and wear and tear, would not exceed 30 cents an hour. The light produced was photometrically equal to 800 gas burners burning 5 feet of gas per hour each. This amount of gas would cost 8 dollars per hour.—*Scientific American.*

A LARGE carpet factory in Philadelphia has also been illuminated by the Brush machine recently.

EDISON'S MICRO-TASIMETER. — Mr. Edison was recently visited at his home in Menlo Park, by Profs. Brackett and Young, of Princeton College, and Prof. Barker, of the University of Pennsylvania, who were desirous of examining his instrument for measuring heat. Mr. Edison has made several experiments with this apparatus, and has succeeded in measuring the fifty-thousandth part of a degree of heat. Prof. Young

and Prof. Brackett will go to Colorado to observe the solar eclipse, and the usefulness of this instrument for measuring the heat of the heavenly bodies will then be tested for the first time.—*The New York Tribune.* (A full account of the micro-tasimeter is given on another page.)

THE TELEPHONE AND THE POSTMASTER-GENERAL.—Messrs. Ashurst, Morris, and Co. write, from Old Jewry, to call attention to the Government Telegraphs Bill, 1878. Clause 3 of this Bill seeks to extend to telephones the monopoly already possessed by the Postmaster-General with respect to telegraphs, and Messrs. Ashurst say:—"If the Bill should pass into law it will practically amount to a confiscation of the invention of the telephone without compensation, notwithstanding that the inventor has obtained letters patent, and that a large amount of capital, to say nothing of time and study, has been expended upon it, and all this upon the faith of the existing law, which confers no such monopoly on the Postmaster-General. It is hardly necessary to point out that Parliament never interferes with vested interests without compensation, and this principle was fully recognised when the Telegraphs Act, 1869, was passed. That Act enabled the Postmaster-General to take away the business from the then existing Telegraph Companies, but the Legislature took care to provide that the latter should receive full compensation."

PROFESSOR GRAHAM BELL has also addressed a letter to the newspapers to the same effect, and a petition has been lodged in Parliament by the Telephone Company against the Bill.

THE project of laying a cable to Lundy Island has been for the present abandoned, owing to the owner of the island (Mr. Heaven) claiming the right to remove any of the officials of the telegraphic company who might annoy his family and dependants. The cable might have proved very serviceable to the shipping of the Bristol Channel.

MR. W. ABBOT, of Tokenhouse Yard, has issued a third edition of his "Submarine Telegraph Map of the World." It is published by Messrs. Bates, Hendy, and Co.

A "JOINT PURSE" arrangement, as regards the Indian and Trans-Indian receipts, has been effected between the Eastern Telegraph Company, the Indo-European Telegraph Department of Her Majesty's Indian Government, and the Indo-European Telegraph Company.

INFORMATION has been received by the Cuba Submarine Telegraph Company of the repair of the second cable belonging to the International Telegraph Company, between Havana and Key West, thereby restoring duplicate communication with the West Indies, Panama, and Demerara.

THE acquisition of Cyprus by the English Government will render direct cable communication between Malta and Cyprus highly desirable, so that we may expect ere long to see a cable laid between these two points. The distance from Malta to Larnaca, the chief town in Cyprus, is 970 miles. The cable may possibly be landed at Baffa, the ancient Paphos, at the extreme west of the island, 900 miles from Valetta. Larnacca is already connected by land-line and cable to Latakia on the Syrian coast. If the Euphrates Valley Railway be constructed, it will open up another telegraph route to India *via* the cables from Malta to Cyprus and Cyprus to Latakia. At present the Island of Candia is connected by cables and land lines to Alexandria, Italy, Rhodes, and Constantinople. It is highly probable that Cyprus will soon be similarly connected to Egypt, Malta, and Constantinople.

THE PATENT LAW AMENDMENT BILL.—In reply to a memorial from the Artizans' and Inventors' Committee urging the Government to give its support to Mr. Anderson's Bill for reducing the cost of patents for inventions, the Attorney-General writes to the effect that he cannot support the Bill.

WE have received with pleasure the first number of *L' Electricité*, the newly revived French electrical journal. It is fitting that a great scientific country like France, the fatherland of Ampere, Arago, and Becquerel, should possess an organ specially devoted to the interests of so flourishing a science as electricity, and we wish it all success. The Count du Moncel has accorded it his valuable help, and M. Wilfrid de Fonvielle, whose scientific chronicles have been justly admired, has undertaken the duties of editor.

HATCHING SILKWORMS BY ELECTRICITY.—According to *Galignani*, it appears that M. Duclaux, Professor of Sciences, at Lyons, has discovered a method of hatching the eggs of the silkworm by means of electricity. The account given is not quite clear, but it consists in taking the eggs when not more than two days' old, rubbing them with an electrified brush, and then dipping them in concentrated sulphuric, chlorhydric, nitric, acetic, or tartaric acid, when they will hatch out. Two crops of silk can in this way be obtained from the mulberry in a single season. It may be added that immersion in water at a temperature of 122° Fah. is said to be equally efficacious.

A NEW Magnetic Observatory was opened on July 20, at Pavlovsk, in Russia. It is an *annexe* of the Central Physical Observatory at St. Petersburg. Observations on the usual meteorological and magnetic elements,

and upon atmospheric electricity, terrestrial currents, and radiation will be made there.

SEATS LIT ELECTRICALLY.—At the Paris Exhibtion there are exhibited some "bancs lumineux" or luminous seats for gardens and public places. They are the invention of Dr. Lacomme, of Paris, and their object is to provide seats and benches for public parks and squares with luminous backs so that all the persons sitting on them may be in the light. For this purpose the backs are hollow and faced with ground or opal glass. In the hollow back is fixed an electric light, or it may be a gas or oil lamp.

FLOATING MAGNETS.—In an article to Siliman's American *Journal of Science and Arts*, Professor A. M. Mayer shows how the magnetic configurations built up by small floating magnets under the influence of induction, illustrate the phenomenon of allotropy, isomerism, expansion or solidification of water, the atomic hypothesis, &c. These figures consist of triangles, squares, and polygons, some having smaller internal figures. They were obtained by suspending a cylindrical bar magnet (387 mm. long, by 13 mm. thick) with its north pole some 60 mm. above a water bath, in which a flotilla of sewing-needle magnets were floated by means of corks. The eyes of the needles were south poles, and appeared above the surface of the water. When the north pole of the large magnet is brought down over them, they at once arrange themselves into figures. Some of these figures comprised as many as 20 needles. The eyes of the needles were inked, and impressions of them taken on paper. Some of the figures were more stable than others.

SOMEWHAT similar electrical experiments to the above have been made by M. de Waha, at Luxembourg, France, by means of a Holtz machine. The inductors of the machine are pointed to the surface of a bath formed of water, with a scum of petroleum or other insulating liquid upon it. When the petroleum layer is thick enough, the water charged by induction from the electrified points burst through the oil to the surface with a kind of explosion resembling a volcanic irruption. Sometimes the currents, which are set up on the surface of the bath, assume a peculiar kind of stability.

ELECTRO-MOTIVE FORCE OF SOLUTIONS.—Further experiments of Mr. James Moser demonstrate that, in an element made of two unequally concentrated solutions of the same salt, and with electrodes of the basic metal, for example, two solutions of sulphate of zinc, with zinc electrodes, the current in the liquid always flows from the solution the most dilute to the most concentrated. The zinc within the former dissolves and deposits itself within the latter.

ELECTROLYSIS.—M. Elsässer (*Deut. Chem. Ges. Ber.* XI., 587) has repeated his experiments on electrolysis by means of a magnesium anode. He confirms his previous results (*Ber.* IX., 1818), and shows that the relation between the volume of hydrogen evolved at each pole is independent of the strength of the current, and also within certain limits of the strength of the solution employed.

POLARISATION OF ELECTRODES.—It has been recently shown by M. Lippmann that for an electrode to become depolarised it should be immersed in a solution formed from the metal of which it is itself composed, thus copper is the only metal which is depolarised in sulphate of copper, zinc the only metal which is depolarised in sulphate of zinc. On the other hand, a metal is polarised in solutions made from other metals, thus copper is polarised in a solution of sulphate of zinc, gold, platinum, &c., while zinc is polarised in a solution of sulphate of copper, gold, platinum, &c. M. Lippmann applies this fact to analysis of metals. If, for example, the metal copper be sought for, a negative copper electrode is dipped into the solution under examination, and if it become polarised under a weak current, the solution contains no solution of copper, One $\frac{1}{5000}$ part of sulphate of copper in the solution can be detected by this means.

WINDING ELECTRO-MAGNETS.—A fact likely to be very useful in making electro-magnets has just been communicated to the French Academy of Sciences by M. Jamin, on behalf of M. E. Bisson. It is found by the latter that if in winding the wire on the core of electro-magnets, the wire, after completing a layer be led back *straight* to the point of departure again to begin the next layer, instead of winding the next layer backwards so as to fill up the bobbin by layers wound in reciprocal directions, as is usually done at present, a gain of one-third in magnetic power will be obtained, every other condition being the same. This gain is manifested either in sliding, pulling, or attraction at a distance. The results have been arrived at by experiments on both small and large electro-magnets.

PORTATIVE FORCE OF MAGNETS.—M. Guidi finds that the weight sustained by an ordinary electro-magnet is always one quarter of that sustained by an electro-magnet with concentric tubes when the weight is in contact with the poles. When, however, the weight is at a distance of half a millimetre from the poles the weight supported by the two magnets is the same, and when the distance is increased still more, the portative force of the tube electro-magnet diminishes indefinitely. Tube electro-magnets would, therefore, be no advantage in electro-motor or dynamo-electric machines.

ELECTRICITY IN PHOTOGRAPHY.—M. Bovin has found that collodion films may be easily removed from glass plates by giving them a charge of positive electricity. Collodion films appear ordinarily to adhere to

the plate by reason of their being electrified negatively. By giving them a positive charge therefore they become neutral, and they may be readily stripped off. A negative charge followed by a positive given to the film demonstrates this theory.

WE notice in the *Official Gazette* of the Patent Office, that in the week ending April 30, Mr. Edison obtained six several patents, three for speaking telegraphs, one for a speaking telephone, one for a telephone signal call, and one for a telephone or speaking telegraph. Mr. Edison assigns each of the inventions to the Western Union Telegraph Company.—*The Operator*, U.S.

THERE are 220 public telephone stations in Germany exclusive of thousands of private telephone lines. In Germany, therefore, the Bell telephone has been made a really useful instrument. In England, on the contrary, for some reason or other, it has been very much talked about, but very sparingly employed. And yet England is a country where such a contrivance should be useful if it be useful anywhere. We trust that this condition of things will speedily be improved.

THE Iquique-Arica cable has been repaired.

WE learn from the *Journal of the Telegraph*, that the suit which Mr. E. C. Benedict brought against the "pooling" arrangement of the W. U. Telegraph Company with the A. and P. has been dismissed.

POLO BY ELECTRIC LIGHT.—A novel and successful application of the electric light was carried out on Thursday evening, the 18th July, on the grounds of the Ranelagh Club, at Fulham. A Polo match was played by the members of the club between the hours of nine and eleven, the meadow being illuminated for the purpose by three electric lamps erected on an equal number of stages in different parts of it; the light thus obtained allowing the spectators to follow the course of the ball easily, and the players to see it even more clearly than by daylight. The experiment was considered highly successful, and is likely to be repeated soon. The electric lamps were provided and superintended by Mr. Edward Paterson, of 3, Bedford Court, Covent Garden.

New Patents.

2852. "An improved method of communication by means of electrical currents between the passengers and officials in railway trains and apparatus therefor."—R. W. HAMMOND (communicated by V. von Scheliba).

2816. "Improvements in magnestising metals, or other substances, and utilising same for producing magnetic, electric, telephonic, microphonic, and acoustic effects."—G. E. PRITCHETT. July 13.

2878. "A new or improved electric motor, parts of which are applicable to other electro-magnetic appliances."—E. J. HARLING, H. BULL. July 18.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

4412. "Electric Lamps."—F. H. ZIFFER. Dated November 23, 1877. 8d. This consists in regulating the carbon points by means of toothed gearing, driven either by the electro-magnetic machine, or the driving shaft. The gearing maintains one or both of the points in a state of revolution round its axis, while at the same time by means of a worm or screw it forces the carbons together as the points are consumed.

4418. "Telephony and telephonic apparatus."—THEODOR WIESENDANGER. Dated November 23, 1877. 6d. This consists of a make and break circuit telephone similar to that of Reiss. (*Not proceeded with.*)

4432. "Improvements in the production and applicacation of electric currents for lighting and other purposes, and in apparatus employed therefor."—J. RAPIEFF. Dated November 24, 1877. 3s. 10d. A full account of this important patent will appear in an early number of the TELEGRAPHIC JOURNAL.

4435. "Electrical apparatus for lighting, &c."—S. A. VARLEY. Dated November 24, 1877. 10d. This consists in improvements on the dynamo-electric machine described in patents No. 3394 of 1866, and No. 1755 of 1867. The mutual reaction machine in question is constructed of bobbins revolving on an axle between the opposite poles of soft iron electro-magnets, a commutator being employed to direct the positive and negative currents generated. The present improvements consist in forming the coils of wooden cores surrounded by iron wires laid parallel to the axis of the core. Over this composite core the bobbin wire is wound. To divide the light, "electric division bobbins" are employed. These are constructed of rings or helices of insulated wire, and layers of iron wire superposed over one another, built up in a similar way to that described in respect to the revolving bobbins, but instead of being wrapped with one continuous length of insulated wire, they are wrapped with two, three, or more insulated wires, side by side, and the insulated wires or helices superposed over one another, are so connected, that when electricity is flowing through the insulated convolutions, the layers of iron wire are magnetised in alternate directions forming armatures or keepers to one another. The separate insulated wires form separate sources of electricity, and are to be connected in circuit with separate lamps.

4464. "Dynamo electric machines."—LOUIS SIMON. Dated November 27, 1877. 4d. This consists in modifying the Gramme machine, so that more of the wire of the armature ring is brought within the magnetic field. (*Not proceeded with.*)

4478. "Preventing collisions on railways."—LUIGI ISIDORO GUANO, of Genoa. Dated November 28. 6d. This consists in arranging at every station or switch an apparatus, whereby the passing train is caused to signal its passage to a point some distance, say several miles ahead on the line, so that a train coming in the opposite direction will know that there is a train advancing towards it, and may stop.

4500. "Electric piles."—G. A. SCHOTH, London. Dated November 29, 1877. 6d. For use in telegraphy, or for medical purposes, these batteries are made of tubes, each tube containing a spiral of copper wire surrounding a zinc rod or pencil enveloped with porous material, containing liquid mercury in its interior to keep the zinc amalgamated. Sulphate of copper solution is the depolariser.

General Science Columns.

IRRIGATION WORKS IN THE DECCAN, BOMBAY.

THE following particulars of some of the largest storage works already completed or under construction in the Deccan will, to some extent, show the magnitude of the principal undertakings in the Bombay Presidency, having for their object the storage of water for irrigation purposes. Works of this character are more expensive, in proportion to the areas for which they are calculated to supply water for irrigation, than ordinary canals, but it must be remembered that they are situated where such canals could not be constructed. The largest work is the Muta reservoir, in the Poona collectorate, which has a storage capacity of 5,226·076 millions of cubic feet, and has been completed at a cost of £261,578. The dam across the river Muta is of masonry, 3,687 feet in length, with a maximum height of 97·84 feet, and having a waste-weir 1,425 feet long. The drainage area from which this tank is supplied is 196 square miles, and the area of the reservoir at full supply level 160,356,000 square feet. The next largest work is the Pangaon Tank, at present in course of construction in the Sholapur collectorate. The drainage area from which this tank is fed is 298 square miles in extent. The tank is retained by means of an earthern dam 15,100 feet in length, and 76·8 feet in maximum height, and with a waste-weir 1,500 feet in length. The area of contour of the Pangaon tank at full supply level is 291,961,000 square feet, and its total capacity 5,020,041,000 cubic feet; the estimated cost of this work is £127,982, being at the rate of £255 per million cubic feet of water stored. The Ekruk tank, also in Sholapur, is a very remarkable work, the dam consisting of an earthen embankment 7,000 feet in length, having a maximum height of 75·66 feet, and a waste-weir 750 feet in length; the drainage area of this tank is 160 square miles, its contour area 202,080,000 square feet, and its available capacity 3,350,030,000 cubic feet. Its cost has been £76,638. The Mhaswad tank, in Satara, which is in progress, has an earthen dam 9,080 feet in length, and 79·79 feet in height, the waste-weir being 3000 feet in length; the drainage area which feeds this tank is 500 square miles; the contour area of the tank, 174,847,000 square feet at full supply level, and its total capacity 3,072,134,000 cubic feet. This work is expected to cost £93,415 when completed. The next largest tank in progress, and the last to which we shall at present refer, has only half the capacity of the one last described; this is the Ashti tank, in Sholapur, which with a drainage area of 92 square miles, and an earthen dam across the river 12,709 feet in length, and 57·75 feet in maximum height, will impound 1,499,470,000 cubic feet of water, having a contour area at its full supply level of 116,610,000 square feet. The waste-weir is 800 feet in length, and the total cost of the work is expected to reach £45,292. These storage works, large as they undoubtedly are, and of modern construction, will not bear comparison in point of size with some of the native tanks to be found in the Madras Presidency and in Mysore. How far works of this character are likely to prove remunerative, or otherwise, is at present a question; but considering their expensive character, it seems hardly probable that they will yield better returns than irrigation canals in other parts of India; and these, as a rule, can hardly be said to be very remunerative. Some of them, it is true, do more than pay interest on their outlay from net receipts, but in many cases their working expenses are not even covered by receipts. Probably, as directly remunerative undertakings, these tanks will not pay, but the indirect benefits they will confer upon the country under their command, may still be such as fully to justify their construction as State works.

THE presidential address of the British Association meeting, which will be held this year at Dublin, will be delivered on the evening of August 14, by Dr. W. Spottiswoode. The two popular evening discourses will, on this occasion, be delivered by two rising men, Mr. G. J. Romanes, whose theme will be "Animal Intelligence," and Professor Dewar who will treat of "Dissociation; or Modern Ideas of Chemical Action."

CANADIAN GRAPHITE.—According to a report by Mr. Hoffman, Montreal, Canadian graphite is fully equal to that from Ceylon for the manufacture of crucibles and similar purposes. It is equally incombustible and free from ash.

SILVERING GLASS.—M. R. Bottger, in the *Deutsche Indust. Zeit.*, gives the following new process for silvering glass which may prove useful for silvering galvanometer mirrors. Tartrate of silver, in very fine powder, is suspended in distilled water, and very dilute ammonia is then very carefully added until the tartrate of silver is dissolved. The operator must satisfy himself that a small excess of the silver salt remains undissolved, and that the liquid gives off no ammoniacal odour. Into this bath the objects to be silvered are placed, after having been carefully cleaned. In about ten minutes they are uniformly covered with a film of silver.

OZONE.—M. Ermine finds that the decomposition of ozone by the light of day takes place slower than in obscurity. Ozone which is allowed to stand some time after its preparation, and is not employed just at once, has a more energetic disinfecting action.

ACOUSTIC REPULSION.—In a closed resonator, a node is formed near the bottom, and the pressure is stronger at the interior than at the exterior: if then, a resonator of paper, or very thin glass, be suspended to a moveable support over a vertical pivot, and furnished with a counterpois, the apparatus will be

repulsed by a sonorous body. The experiment succeeds above all with the resonance box of a diapason, or a plate fixed at its centre. A continuous rotation is attained with four resonators suspended at the arms of a cross-shaped support, and the repulsion can be measured by fixing the resonator to a torsion balance. In a sonorous tube, the pressure, even at the centres, is always a little stronger than the exterior pressure: the air ought, therefore, to escape from the tube. It has been remarked that in the tubes of Kundt, there is a current of air along the axis of the tube, and a current in the contrary direction along the walls. This emission of air from a sounding tube is proved by placing a resonator filled with smoke in front of the resonance box of a diapason, when the smoke will escape from it. This current of air when the tube is placed before the centre of a vibrating plate will disperse lycopodium powder. When a conical resonator open at its two extremities, is put in front of the end of a Kundt tube, the draught will blow a candle flame, or turn a light mill.

American Electro-plating.—Local electro-plate manufacturers are much exercised over the introduction of American productions in their specialty, which has up till recently been free from transatlantic competiton. I am informed by several local employers that American electro-plate is undoubtedly finding a ready sale in this country; but that it is "Britannia metal electro-plated," and that instead of calling it "soft metal" to distinguish it from nickel silver electro-plate, as English manufacturers do, the Americans designate it "hard white metal," which has induced dealers to purchase it, under the impression that they were getting "hard metal" ware, *i.e.*, nickel silver electro-plate.—*Sheffield Correspondent of the Engineer.*

The Chinese make a concentrated essence of wine which, dissolved in water, makes an excellent beverage.

It is proposed to erect light bridges across the Paris boulevards, at the most thronged points. Something of the kind would be a convenience in many parts of London.

M. Mouchot, the French apostle of solar cooking, is at present making coffee, distilling wine, and roasting beef by the reflected sunlight, in the grounds of the Paris Exhibition.

Tasmanian Copper.—A promising discovery of copper ores has been made at Badger Head, on the north-west coast of Tasmania, about seven miles from Tamar Heads. A company with a nominal capital of £20,000 has been formed to work three sections of 80 acres each. An application for a fourth section has been made, which will make the total area to be held by the company 320 acres. Several assays of ore taken from the lode show upwards of 27 per cent. of copper.—*Engineering.*

City Notes.

Old Broad Street, July 30th, 1878.

The meeting of the Globe Telegraph and Trust Company is being held as we write, and as the meetings of the Anglo American and the Direct United States Cable Companies do not take place until Friday, we confine ourselves, of necessity, to adverting to the reports. From that of the Globe Company, which is for the year, we find that the net revenue amounts to £154,404 10s. 6d., which with the balance brought forward makes a total of £154,824 10s. 8d. The sum of £115,399 4s. of this amount has been distributed in the *interim* dividend, and the directors have written £500 off the Parliamentary expense account. The directors now recommend payment of a final dividend for the year of 3s. per share on the Preference Shares, and of 2s. per share on the Ordinary Shares, making with the former distribution, a total dividend for the year of 6 per cent. upon the Preference Shares, and 4 per cent. upon the Ordinary Shares, leaving a balance of £425 6s. 8d. to be carried forward. In the next paragraph, the directors express their complacency that their anticipation of an increased revenue arising to the Globe Company "by the cessation of hostile competition between the Atlantic Telegraph Companies," have, "so far," been realised; and they also note with satisfaction, that "the market value of the stocks and shares held by the company show an improvement as against this time last year of about 6 per cent." They are thankful for mercies by no means large. Last year it is true they had the unpleasant duty to perform of telling the shareholders they must put up with a reduction of dividend; but there is nothing we can see, beyond the fact that the dividend is not again to be reduced, that calls for congratulation. Whatever efforts have been made to get rid of Anglos, the holding of the Globe Company is still very great; still, as it was last year, a third of the shareholders' money is invested in that enterprise. We naturally turn to the report of the Anglo-American Company, and the figures we find there are not, we may say, generally of a nature calculated to inspire the belief that the larger the stake of the Globe Company in the Anglo, the better will it be for the Globe shareholders. The dividend is indeed the same as it was last year—be it observed, this is after a clear six months' experience of the amalgamation which was to make the fortunes alike of holders of Anglo and Globe shares—but the total receipts from January to June, less the balance brought over from the last account, are £271,158 as compared with £281,813 in the previous half year; while the total expenditure is £44,265 as compared with £42,591. Attention is called to an increase in the traffic receipts, which is, of course, assigned to the circumstance of the 3s. rate being in force. The sum of £75,000 has been properly added to the reserve fund; but, we repeat, that with such an enormous capital the reserve fund of the Anglo Company should be much increased. There is nothing in the report which will tend to ease the minds of the Globe shareholders. Taking everything to be as it is stated to be, what improvement has the amalgamation really effected in the prospects of either of the companies? We hope this question will be taken up at the respective meetings.

Touching the Direct Company, the dividend in that case also remains stationary. But the directors affirm that that is in deference to the wishes of the shareholders, who, it is averred, desired that the dividend should not be increased beyond 5 per cent. until a substantial reserve fund is established. The shareholders are right in so desiring, and it is satisfactory that £32,155 has accordingly been added to the fund. It

might have conduced to the benefit of the shareholders if the directors of this and other cable companies had arrived some time back at the conclusion that it is "a primary duty" for them "to secure as far as possible the permanency of the property by the practical guarantee of a substantial reserve fund against the contingencies of breaks and competitions." Over and over again this duty has been drummed by us into the ears of all concerned, and until recently it has been as persistently ignored. There are several things in the Direct report which will probably engage the attention of the shareholders' meeting. For instance, the directors are still restless for an extension of the amalgamation scheme. Thus they hope that negotiations now proceeding between the Direct and the Dominion Telegraph Company "will terminate all existing difficulties with that Company and result in a supplemental working agreement beneficial to both companies." This is a matter which, we apprehend, requires discussion. What is the nature of the proposed supplemental working agreement? The shareholders will be to blame if they allow the directors to enter into another combination without a complete understanding. What benefit are they reaping from the combination that was formed for them with the Anglo Company?

At the recent meeting of the Eastern Telegraph Company, the proceedings were almost entirely of a formal character. Mr. Pender reviewed the progress made by the Company during the past year; and the report was unanimously agreed to, as also the agreement between the Indo-European and the Eastern Company, which was specially put to the meeting. We observe that the chairman, in alluding to the fact that the revenue of the company for the past half-year was smaller than that for the corresponding period in 1877, attributed the decrease to the cessation of the Russo-Turkish war. No doubt that is so; and other companies have found their revenue to have diminished from the same cause. We anticipated that some further explanation would be volunteered at the meeting of the large sum of £26,179, mentioned in our last issue as being set down under the head of "Special Expenditure," than was offered. No less than £21,736 of the amount was, the chairman stated, expended in repairing and altering the Lisbon and Vigo cables; but it would surely have been interesting to some of the shareholders to have learned whether the £12,104 "ship's expenses" represents any part of the cost of the directors' trip to the Mediterranean, or whether those gentlemen defrayed their own expenses. They ought to have the credit of generosity, if they have been generous; but if they have charged the company with the cost of the excursion, the shareholders, one would think, would, for their guidance in the future, like to know what sum was actually absorbed in the affair. Nor should the £1,556 for repairing cables have been included in the special expenditure. We shall lose no opportunity that offers of protesting, on principle, against any charge being made by any company, on capital which ought obviously to be charged to revenue. Railway companies are not the only or the worst sinners in this respect.

The Eastern Telegraph Company (Limited) announces that the coupons on the Five per Cent. Debentures will be payable on the 1st prox. at the banking house of Messrs. Glyn, Mills, Currie, & Co.

The shareholders of the Campanhia Telegraphica Platino Braziliera will hope that the directors' expectation of shortly being in a position to recommend the payment of a dividend will be realised. It will be something even for them to know the "exact state" of their affairs.

We note that the coupons of the Six per Cent. Debentures (Eastern Extension Telegraph Company) is now payable at the Consolidated Bank, and that the half-yearly interest on the A and B Debentures of the Western and Brazilian Company is also payable at the offices of the Company.

The following from the morning papers refers to the Anglo-American Telegraph Company's lost cable:—

"*To the Editor.*

"SIR,—The steamships *Seine* and *Calabria*, which were sent out by this Company at the end of May for the recovery and repair of the 1866 cable, returned to London this morning.

"The cable has been hooked several times, and partially raised to the surface; but the outside iron wires were so weak from the effects of oxidation that, its repair was considered impracticable by the engineers in charge of the expedition.—I am, Sir, your obedient servant.

"H. WEAVER, General Manager.

"Anglo-American Telegraph Company (Limited),
"26, Old Broad-street, London, E.C., July 27."

The following are the latest quotations of telegraphs: Anglo-American, Limited, 35-36; Ditto, Preferred, 61¾ 62¼; Ditto, Deferred, 91-92; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6¾-7; Cuba, Limited, 9¼-9¾; Cuba, Limited, 10 per cent. Preference, 17-17½; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 9½-10; Direct United States Cable, Limited, 1877, 13⅞-14⅛; Eastern, Limited, 7¾-8; Eastern, 6 per cent. Debentures repayable October 1883, 108-111; Eastern 5 per cent. Debentures, repayable August 1887, 103-105; Eastern 6 per cent. Preference, 11¾-12; Eastern Extension, Australasian and China, Limited, 7¾-8; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 109-112; German Union Telegraph and Trust, 8½-9; Globe Telegraph and Trust, Limited, 5¼-5¾; Globe 6 per cent. Preference, 11-11¼; Great Northern, 8¾-9; Indo-European, Limited, 20-21; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 9¾-10¼; Reuter's Limited, 10-11; Submarine, 225-230; Submarine Scrip, 2-2¼; West India and Panama, Limited, 2⅜-2⅝; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited, 4½-4¾; Ditto, 6 per cent. Debentures "A," 98-101; Ditto, ditto, ditto, "B," 96-99; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds, 116-120; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 31¾-32¼; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2¾-3; India-Rubber and Gutta-Percha and Telegraph Works, Limited, 29-30.

We can only very briefly refer to railway matters. Sir Edwin Watkin's scheme of salvation for the East-London Company has fallen through, the Select Committee of the House of Commons having rejected the necessary bill. It remains to be seen whether an alternative plan can be carried through. The dividend of the Metropolitan Company is satisfactory, and for the first time in the history of the District Company, a dividend, though it is but ½ per cent., has been declared on the ordinary stock. But it is the beginning of good things. We are the more inclined to believe this, because the two companies are, at length, acting in harmony, so far at least as the completion of the inner circle scheme is concerned. The Brighton and South Coast shareholders have every reason to be satisfied; the South-Eastern need not grumble; the directors of the Manchester and Sheffield have an extra ¼ per cent. at their disposal; the Great Eastern Company exists. We may hereafter make some comments on the position and prospect of some of the companies.

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ERNST WERNER SIEMENS.

ERNST WERNER SIEMENS was born at Lenthe, near Hanover, on the 13th December, 1816. He is the eldest of a large family, and the names of the brothers Werner, William, Carl, and Frederick Siemens, have long been well known in England in connection with scientific and technical works. A biographical sketch of Dr. Charles William Siemens, who has become one of England's foremost scientific men, has already appeared in No. CXX. of this Journal.

In 1834, on the completion of his school education at the college in Lübeck, Werner Siemens entered the Prussian Artillery as a volunteer, and afterwards attended the Artillery and Engineers' School in Berlin. In 1838 he obtained an officer's commission

and devoted himself sedulously to the study of chemistry and physics, for which he had previously entertained a strong liking.

A patent was granted him in Prussia in 1841 for electro-gilding and silvering. In 1842 he and his brother William Siemens took out a patent for a differential regulator.

In 1844 he was appointed to the artillery workshops in Berlin, where he turned his attention earnestly to telegraphy; and in 1845 patented his dial and printing telegraph instruments, which were used later all over Germany, and were based on the self-breaking principle of the Neef s hammer.

These instruments worked synchronously, and when in circuit all stopped at the letter or type corresponding to that of the key pressed down, and a printed impression of the letter was made. The self-acting alarms that were also first constructed about this date, worked on the same principle.

These labours led to his being made member of a Commission, which was appointed in Berlin in 1846, for the introduction of electric in place of the optical telegraphs, which had been in use up to that time. As member of this Commission, Werner Siemens in the autumn of 1846 recommended gutta-percha (just then becoming known) for the insulation of underground lines. He constructed in the following year (1847) a screw press machine to cover wires with gutta-percha, made plastic by heat but without a seam. This machine, in a slightly modified form, is to this day employed in all cable factories for the same purpose.

In 1848 his military duties called him to Kiel, where, in conjunction with his brother-in-law Professor C. Himly, he laid down the first electric submarine mines. They served to protect the town of Kiel, and saved it from being bombarded by the Danish fleet.

The Prussian Government in the autumn of 1848 deputed him to lay the first great underground telegraph line from Berlin to Frankfort-on-the-Main, and in the following year another from Berlin to Cologne, Aix-la-Chapelle, and Verviers. Werner Siemens now left the army and government service, and devoted himself henceforth to scientific pursuits and the management of a telegraph factory, which he and Mr. Halske established in 1847. The firm has since then acquired a world-wide reputation, and is indissolubly connected with the growth and progress of telegraphy. During the laying of the first underground lines Werner Siemens had observed the then remarkable phenomenon of electro-static induction, which exercised so retarding an action in the working of those lines. He described the phenomena in a paper communicated to the Paris Academy of Sciences in the year 1850. In this paper he set forth the results of this induction, as shown in the retardation of the current, and likewise gave methods for the determination of the position of faults in the insulation by means of current measurements.

From this period an almost uninterrupted series of scientific and technical discoveries and inventions emanated from him and from the factory under his direction. The most notable works and papers are the following :—

In October, 1845, a machine for the measurement of small intervals of time and the speed of electricity by means of electric sparks, and its application in 1875 for measuring the speed of the electric current in overland lines.

January, 1850, a paper on telegraph lines and apparatus, in which the theory of the electro-static charge in insulated lines, as well as methods and formulæ for the localising of faults in underground wires were first established.

In 1851, the firm erected the first automatic fire telegraphs in Berlin, and in the same year Werner Siemens wrote a treatise on the experience gained with the underground lines of the Prussian telegraph system. The difficulty of communicating through long underground lines led him to the invention of automatic translation, which was afterwards improved upon by Steinheil; and in, 1852, he furnished the Warsaw-Petersburg line with automatic fast-speed writers. The messages were punched in a paper band by means of the well known Siemens' lever-punching apparatus, and then automatically transmitted in a clockwork instrument.

In 1854, the discovery (contemporaneous with that of Frischen) of simultaneous transmission in opposite directions, and multiplex transmission by means of electro-magnetic apparatus.

In 1856, the Siemens' magneto-electric dial instrument, giving alternate currents, was constructed. From this apparatus originated the well-known Siemens' armature, and from the receiver was developed the Siemens' polarised relay, with which the working of submarine and other lines could be effected with alternate currents; and in the same year, during the laying of the Cagliari-Bona Cable, the construction and first application of dynamometers, which have become of such importance in the operations of cable laying; also development of the theory of submerging cables in deep water.

In 1857, researches on the subject of electro-static induction and the retardation of the current in insulated wires representing Leyden jars. In these researches he developed mathematically Faraday's theory of molecular induction, and thereby paved the way in great measure for its general acceptance. The construction of the ozone apparatus; also telegraph instruments with alternate currents, and translation and automatic discharge for cable lines. The Sardinia, Malta, and Corfu Cable was in the same year worked with such instruments.

In 1859, the construction of an electrical log; the discovery of the heating of the dielectric by induction; the introduction of a reproducible standard resistance measurer (Siemens' Unit); the construction of resistance bobbins and the testing of insulated wires by systematic methods were also effected by him; also researches on the influence of heat on the electrical resistance of metals, and the establishing of methods and formulæ for testing resistances, and for the determination of faults by means of resistance measurements instead of with current measurements as formerly used. These methods were adopted by the electricians to the Government, Messrs. Siemens Bros., London, during the manufacture of the Malta Alexandria Cable, which was the first long cable subjected to a system of continuous tests. The same system with improved apparatus is still employed for the testing of submarine cables.

In 1861, he showed that the electrical resistance of molten alloys is equal to the sum of the resistances

of the separate metals, and that latent heat increases the specific resistance of metals in a greater degree than free heat.

In 1864, researches on the heating of the sides of a Leyden jar by the electrical discharge.

In 1866, the establishing of the theoretical principle of Dynamo-electric machines, which led to the construction of Dynamo-electric mine exploders and light apparatus.

In 1874, a treatise on the theory of the laying and testing of submarine cables.

In May, 1875, researches on the influence of light on crystalline selenium; and in 1876 and 1877 on the change of conducting power of selenium by heat and light.

In 1878, some papers on telephony.

Werner Siemens' scientific knowledge and inventive genius combined with the great mechanical ability of his partner, Mr. Halske, soon developed the telegraph works of Siemens and Halske in Berlin into a large establishment, from which Mr. Halske retired in 1867. This development was also, to a great extent, owing to the circumstance that the firm produced a number of eminent engineers, who have for the most part remained in their service. Many instruments and new constructions are due to these engineers, whose exertions have largely contributed to the fact that the constructions of the firm are generally recognised and accepted as models. In 1865, Werner Siemens introduced pneumatic despatch tubes into Berlin; the system adopted there served as a model for that laid down in London by Siemens Bros. in 1871. The railway signalling and block system of Siemens and Halske, which has been adopted by many Continental railways, was the first to ensure a forced dependence between the electric and semaphore signals and the position of the points; the automatic cylinder transmitter, with which Morse signals are transmitted from a key board and registered automatically; an automatic fast speed printer, electric lamps, &c., are further evidence of the inventiveness of the firm.

The alcoholometer ranks as one of the most ingenious of Werner Siemens' constructions. This apparatus registers with perfect accuracy the actual quantity of absolute alcohol contained in the spirit, which is passed through it. In Russia it is adopted to facilitate the levying of the excise taxes on spirit, and many thousands of them have been manufactured at special works at Charlottenburg, near Berlin.

About 1,000 workmen are employed at the Berlin telegraph and cable works, in the latter of which the underground Cables between Berlin, Hamburg, and Kiel, and also the Strasburg-Frankfort and Hamburg Cuxhaven cables, have lately been made. The firm have also a porcelain factory in Russia for the manufacture of insulators. In all the international exhibitions, Siemens and Halske obtained the highest awards for their apparatus. They were also among the first to construct telegraph lines in Germany, and other countries. In 1854 a branch firm was established at St. Petersburg, under the direction of Carl Siemens, who became a partner. A complete network of Government telegraph lines for Russia was constructed and erected by this firm, in whose hands the technical supervision of the lines remained for twelve years. In the year 1857 a branch of the firm was established in London, and directed from the beginning by C. W. Siemens. This branch, at a later period, took the name of Siemens Bros., and has, in connection with the Berlin House, carried out a series of important works, among which may be mentioned the construction of the Indo-European line, and the manufacture, as well as laying, of the Direct United States Cable. Carl Siemens came to London after having organized the copper mines and petroleum works which the firm possess in the Caucasus. For his scientific labours, Werner Siemens had in the year 1860 the degree of Doctor (*honoris causa*) of the Berlin University conferred upon him, and in the year 1873, he was elected member of the Berlin Royal Academy of Sciences. He was for a long time member of the Prussian Parliament, and is Vice-President of the Society for the Advancement of Industry in Berlin; member of the Asiatic Society in Calcutta; Hon. Secretary for Germany of the London Society of Telegraph Engineers, &c., &c.

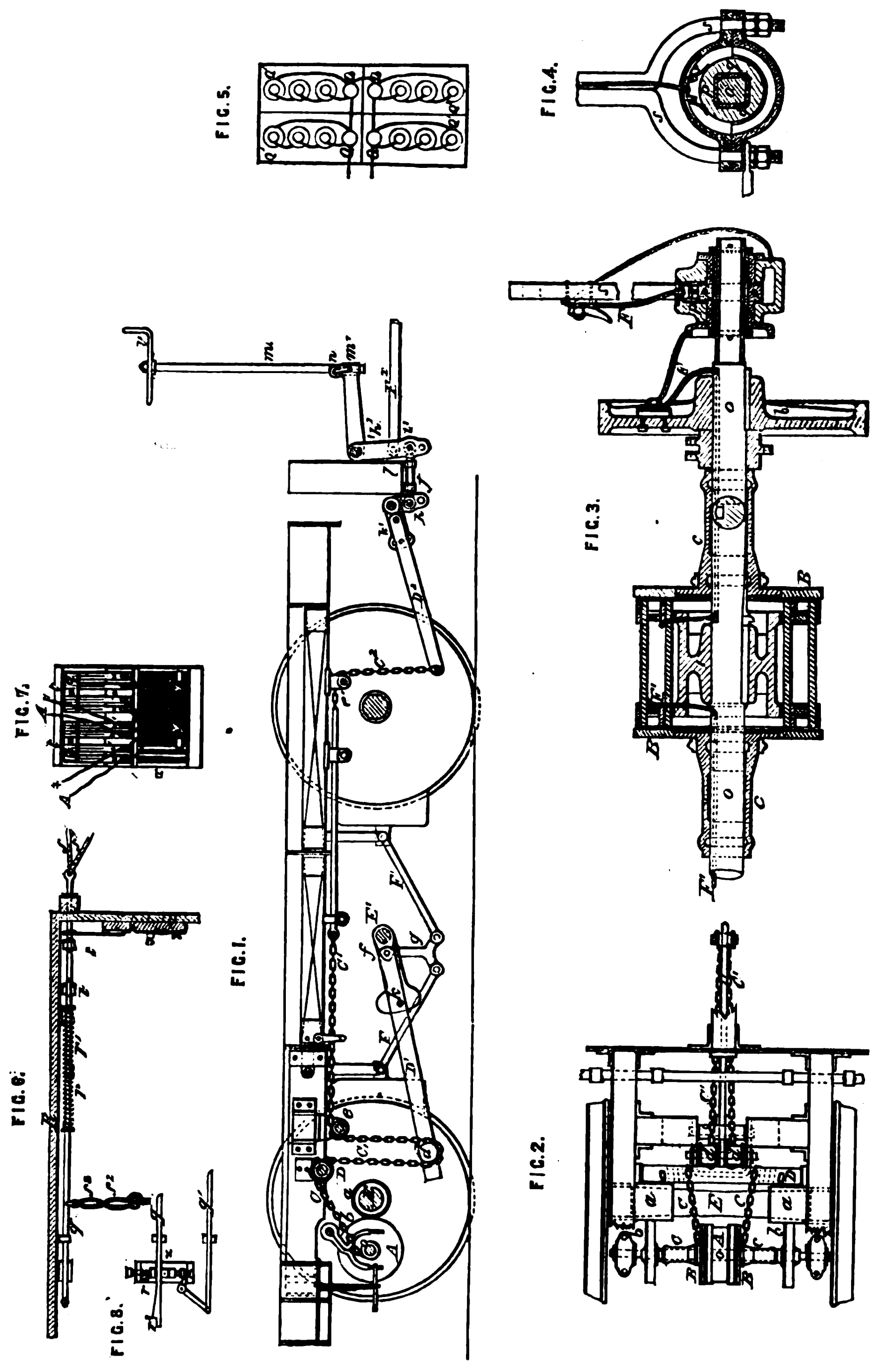
Not the least important of his many labours was the obtaining for Germany a practical patent law, after agitating this subject for a number of years, in connection with the society for Patent Protection, which he founded, and of which he was appointed permanent president.

ACHARD'S ELECTRIC APPARATUS FOR ACTUATING RAILWAY BRAKES.

THE great importance of an efficient system of railway brakes is now fully recognised, and many and ingenious are the devices which have been invented for effecting the object in view.

A point of special importance in brakes is that their action should be as instantaneous as possible. An electrical arrangement would seem to be one eminently fitted for effecting this instantaneously, and, therefore, likely to prove effectual in practice. M. Achard has given very considerable attention to the subject of electrical brakes, and his inventions are therefore worthy of record. In the different arrangements which M. Achard has designed, the brake lever is lifted by one or several chains, the winding of which is effected on a shaft or a sleeve receiving a rotary movement of the axle of the vehicle, through the intermediation of an engaging apparatus. The parts which serve for putting the brake in action, therefore, serve to effect at the proper moment the engagement of an axle which turns continuously with the shaft or sleeve of the chains. It is this mode of engagement which forms the common characteristic feature of his invention.

Fig. 1 is a longitudinal section of the frame of a tender provided with the electric brake, the electro-magnet actuating simultaneously both the break of the tender and that of the locomotive; fig. 2 is a plan of a portion of fig. 1. On the rear axle E, of the tender, sleeves or collars *a*, are keyed, which drive by friction the pulleys *b*, fixed on the shaft O, of the 4-pole electro-magnet A. Opposite each of the two faces of the magnet are arranged, at a slight distance, the plates B, B, which form the armatures; these plates carry sleeves *c*, *c*, in which the shaft O, of the



ACHARD'S ELECTRIC APPARATUS.

magnet turns freely. Chains C, C are, on the one hand, fixed to these sleeves near the plates B, and, on the other hand, wound in spirals on a drum D, situated at the upper part of the frame. To this drum are fixed the ends of the chains C^1, which descend vertically, pass round the rollers *d*, and extend to *e*. In cases where the electric brake is applied to one carriage or a tender only, that is to say, when the magnet commands the brake of only one vehicle, the chains C^1, terminate at *e* in a fixed point. The rollers *d*, are situated at the end of the lever D^1, which, pivoting around the axis E^1, lift, through the intermediation of the pin *f* and lever *g*, the brake rods F, and produce the "brakeing" of the wheels by the blocks. When the magnet has to work both the break of the tender and that of the engine, as is seen in fig. 1, the chains C^1, pass over a roller *e*, then finally lead to a rod supported by rollers, and at the end of which is fixed the chain C^2. This chain, which commands the brake of the engine, passes over a roller e^1, then descends, and is fixed to the lever D^2. This lever actuates the lever *h*, which, oscillating around the axis *i*, communicates motion to the lever h^1 through the intermediation of the connecting rod *j*. Lastly, to the lever h^1 is connected the rod E^2, which acts directly on the brake shaft of the engine. This part of the brake is not shown in the drawing.

When the magnet A acts, and causes the winding of the chains C, these lift at once the two levers D^1, D^2, and consequently produce the simultaneous application of the tender and the engine brakes. The sleeves *c*, *c*, of the plates B, B, should be longer when they work the brake of a single vehicle, as they have to wind part of the chain C^1 and the chain C^2. However, the rotation of the magnet is so rapid that the brakeing of the wheels of the tender and engine is effected quite as instantaneously.

In order to release the brakes, the electric current is interrupted, and a reverse current sent. The armatures are pushed back, and at once become loose, the chains unwind, the large levers fall, and the brake blocks separate from the wheels. To facilitate the release of the brakes, the chains C, are made a little oblique, as seen in the plan, fig. 2, in relation to the plates B, B. The winding of these chains on the drum D, is such that this obliquity is preserved, whatever be the amount of chain wound.

The intermediate levers between the large lever D^2 and the rod E^2 take their point of support on the rear cross beam of the engine frames. This is important for the following reason:—When the train is in motion the rear beam of the engine and the front one of the tender separate a little, owing to the play allowed by coupling. Now, the lever D^2, the rod E^2, and the parts of the brake of the engine, could not allow of this separation if they were fixed on the cross beam of the tender. While being jointed to the cross beam of the engine there is only a slight deviation of the chain C^2, a deviation which does not prevent the working of the apparatus.

The regulation of the brakes, according to the state of wear of the blocks, is made by the pins *k* and k^1 of the levers D^1, D^2, and by the displacement of the axes *i*, i^1, by means of double-threaded nuts *l*.

The working of the brake of the locomotive, independently of the electric apparatus, can be effected by a hand wheel *v*, provided with a threaded rod *m*. This rod carries a pin m^1, which actuates the end of the lever h^1; the groove *n*, of this lever is to permit of the action of the electric brake when the wheel *v* and its rod remain fixed.

The way in which the electric current is established and transmitted to the electro-magnet of each vehicle is as follows:—

In the front and rear vans a pile and a commutator are placed; this arrangement is necessary to avoid the breaking up and re-making of the train at each end of the line for the up and down journeys. Each pole of the pile is in communication with a wire which extends from the tender to the rear van at each side of the train, passing under the frames. A current is thus established at each side of every carriage of the train to each of the two wires, for every carriage, and for the tender a special wire is connected in communication with the 4-pole electro-magnet. The arrangement devised for passing the electric current into the electro-magnet, as well as the mode of supporting the shaft of this magnet will be fully understood on reference to figs. 3 and 4, which represent on a larger scale respectively a longitudinal section through the shaft of the magnet, and a transverse section through one of the supports of this shaft. The magnet shaft O, is square at the end to receive a bronze bearing *p*, keyed by the wedges *q*, of hard wood forcibly driven in. The bearing turns in a cast-iron plummer block P, fixed to the support S. *b* represents a friction-pulley keyed on the shaft O. The 4-pole magnet is shewn in section as well as its armatures B, and their sleeves *c*, loose on the shaft O. F is a wire connected to one of the wires of the general circuit; it leads to the plummer block P, above and below near the oil reservoir. The current passes by the springs *r*, to the bearing *p*, which the wood wedges insulate; then finally reaches the electro-magnet, following a wire fixed first to the pulley *b*, and which afterwards follows a longitudinal groove of the shaft O.

A wire F^1, connected to the second wire of the general circuit, leads to the other side of the magnet. The pile arranged in each van is a strengthened pile of the "Planté" system. It is formed of four elements, each arranged in a special case, as seen in fig. 5. Each of these elements comprises a Planté pile Q, formed of two discs of lead in spiral form, dipped in a bath of sulphuric acid; these discs communicate on the one hand with the poles of three elements of the Daniell pile Q^1, connected in tension. During work, the current of the Daniell piles produces the superficial oxidation of the lead discs, and peroxide of lead is formed. These latter communicate on the other hand with the wires which make the turn of the train, that is to say, which are in communication with the electro-magnets; when it is wished to apply the brakes, the circuit of the Planté pile is closed, peroxide of lead is decomposed, and the decomposed water is recomposed; the lead is regenerated; there is thus developed an electric current of very great intensity, to which is further added that of the Daniell piles. Under these circumstances the Planté piles play a part analogous to that of Leyden jars in static electricity; they constitute real accumulators. The peroxide of lead, which is formed between the stations under the action of the current from the Daniell piles, is decomposed at the moment of actuating the brakes, producing a very powerful electric current.

It is by combining this strengthened pile that the stoppage of a whole train in a very short distance can be caused, and at the relatively small cost which the maintenance of 12 elements of a Daniell pile requires.

The arrangement of the commutator which is employed to produce instantaneously on the one hand the sending of an electric current into the 4-pole electro-magnet, and on the other hand the cessation of this current, and the sending of a reverse current, which destroys the existing current and separates the armatures from the magnets, is as follows :—The commutator is represented in side view in fig. 6, and in end view in fig. 7. It is fixed to the platform R, of the van. It is composed of two rods q, q^1, to which are attached cords s, s^1, which lead to the engine to the hand of the driver. The cords s^2, s^3, allow in like manner the guard of the train to actuate these rods. Each of them carries two metal bars t, insulated by wooden boards, and intended to put each pole of the pile in communication with the poles of the electro-magnets by the train wires. For this purpose, by producing a traction on these rods q, q^1, the metal bars t, come in contact with metal contacts u, u^1, communicating, some with the pile, and the others with the electro-magnets. The sign, +, indicates on the drawing the contacts which communicate with the positive pole of the pile; the sign, —, those which communicate with the electro-magnets. The direction of the wires will be sufficiently understood by the drawings. The rod q, serves to transmit the current, and by working the rod q^1, a current, the reverse of the preceding, is sent to the electro-magnets, as the arrangement of the wires shows. It may be remarked that the springs r, r^1, which surround the rods q, q^1, constantly disengage the bars t from the contacts u. But, on the other hand, when the cord s or s^2 is pulled violently, the rod q is put in action to send a current. This rod is kept alone in contact with the corresponding contacts, and therefore the electric current circulates so long as the opposite rod q^1, is not acted upon to produce a current the reverse of the preceding. But also the putting in action of this last rod q^1, instantaneously produces the separation of the rod q, by the spring r, and consequently the interruption of the existing direct current. Thus, then, the direct current lasts for a certain time, the rod q, maintaining it alone, and closing the circuit so long as the rod q^1, is not pulled; then the direct current ceases, and a reverse current passes. This latter is of very short duration, the rod q^1, not maintaining it alone. Further, it should be less intense than the direct current, to prevent a winding of the chains, which would again cause the brakes to be applied. For this purpose the resistance of the wire corresponding to the positive pole of the pile in its passage from the contact u, +, to the contact u^1, +, is increased; this additional resistance is obtained by means of an iron wire x, rolled around a board. The contacts, u, +, and u^1, +, communicate with metal plates y, screwed on the board in contact with the iron wire; by varying the distance of these plates y, the intensity of the resistance is varied, and consequently that of the reverse current.

In order to carry out the above described action of the rods q, q^1, the following arrangement, shown by fig. 8, has been devised. This fig. is a portion of the commutator in plan, the platform R, being supposed removed.

The rod q, has at its end an inclined part forming a catch r^2; this inclined part passes through a guide z, which pushes against a small spring r^3. When the rod q, is pulled, the inclined part pushes aside the guide z, and when this has been passed the spring r^3 acts and retains the bar by its catch r^2. If in this situation the second rod q^1 be pulled the piece which is jointed to its end pushes the guide z, and allows the rod q to return.

M. Achard has also devised an arrangement of his brake to be used where it is desired to prevent the continuous rotation of the shaft of the electro-magnet through the axle, as in the plan just described.

SOME ELECTRICAL EXPERIMENTS WITH CRYSTALLINE SELENIUM.

By ROBERT SABINE.

(*Continued from page* 316.)

Resistance altering with strength of Current.—Professor W. G. Adams has pointed out that when the battery power is increased the apparent resistance of the selenium is diminished. In some of the specimens of selenium which were tested, it was found that while the current was weak, up to a certain limit, the resistance *increased* in one direction and *decreased* in the other direction; but after passing the limit in question, the resistance *decreased* in both directions for any further increase of current.

One plate of selenium, annealed at 200° C., was kept at a constant temperature, and measured in a Wheatstone bridge, the proportional resistances of which were respectively 1000 and 100,000 ohms. The selenium was inverted each time by a commutator, so that measurements were repeated in both directions, whilst the currents in the bridge resistances always went in the same direction.

Current in selenium.	Measured resistance.	
	Current direct.	Current inverted.
microwebers.	megohm.	megohm.
2	·4107	·4093
4	·4119	·4080
6	·4128	·4072
8	·4131	·4063
10	·4133	·4056
12	·4133	·4050
14	·4133	·4047
20	·4130	·4038
30	·4126	·4023

A like result was found with a second plate, the resistance of which was smaller.

In each case it was found that the resistance of the selenium had somewhat increased during the measurement, due probably to heat generated by the current.

The behaviour of the selenium in these experiments is open to one of two interpretations. If due to resistance, the alteration is possibly a consequence of the cooling and heating effects of the

junctions, as was observed by Peltier between antimony and bismuth; if due to electromotive force, it is probably a simple consequence of electrolytic polarization.

It was found that when the current was reversed, two or three minutes were required to arrive at the settled value corresponding to the new conditions. This difference was small but distinct, and would be such as would correspond with change from heat to cold, or *vice versa*.

On removing the battery and inserting a galvanometer, the discharge current which issues from the selenium is in the opposite direction to the battery current, and agrees with the thermo-electric current which would result from the Peltier effect.

On the other hand, the supposition that the behaviour is due to polarization is the more probable. The increase of the resistance with increasing current (when weak) in one direction, indicates the existence in the selenium of a small independent electromotive force, and leads to the suspicion that a portion of the material in contact with one of the platinum electrodes is in an electrolytic condition, or both perhaps, one being more so than the other. As the measuring current increases in strength, it appears to polarize the electrodes in the selenium, as in an ordinary electrolytic conductor, and the small independent current is overpowered and lost sight of. The apparent decrement of resistance by increasing the battery, is probably due to the fact that the polarization increases in a less ratio than the measuring current, so that when this current is weak the polarization is proportionally stronger, and the apparent resistance higher, than when the measuring current is strong. The discharge after removing the battery is such as would answer to the depolarization of an electrolyte.

Electromotive force of Crystalline Selenium.—The action of light in modifying the conductivity of selenium is evidently a surface action, the effect of which penetrates very little, if at all, into the mass. It therefore occurred to the author that the phenomenon could best be studied, particularly in relation to heat, by making up the selenium plate in the form of a galvanic element. By this means we can deal with the surface without reference to the interior, both as regards light and heat.

A plate of crystalline selenium was prepared at 200° C. with a platinum wire fused into it, by which it was suspended in a test-tube. The back of the plate and the platinum wire near it were covered with a black insulating varnish. The tube was then placed in a light-tight box, in which a shutter could be opened to admit light to the uncovered face of the selenium. A pole of platinum foil was placed in the tube, and distilled water sufficient to nearly cover the selenium plate. This selenium (galvanic) element, when in the dark, gave an electromotive force of 0·112 volt, the selenium being positive to the platinum. On admitting diffused daylight, the direction of the current was changed, the selenium becoming negative to the platinum, with an electromotive force of 0·056 volt; so that by the admission of diffused daylight the selenium surface had become very much less electropositive than it was in the dark.

Two similar plates of selenium were prepared and placed side by side in a suitable cell, which was enclosed in a light-tight case with two shutters, by means of which light could be admitted to one or the other of the plates at pleasure. Distilled water being poured into the bottom of the cell, so as to reach about three-fourths up each plate, the electromotive force between them was measured with an accumulator, discharge-key, and galvanometer.

Both plates in the dark gave a very slight current. Then light was admitted by one of the shutters being opened. The plate on which the light fell instantly became electronegative. The consecutive readings were :—

—0·05 volt.
—0·04 „
—0·03 „

Then that shutter was closed, and, after a few minutes, the other opened. The readings were now :—

+0·09 volt
+0·08 „
+0·07 „

On connecting a galvanometer direct between the poles and observing the deflection, it was found that the current immediately following each reversal was higher, and that it subsided to a lower reading in a short time. This was probably due to polarization of the plates, and is exactly what might be expected.

(To be continued.)

AN ELECTRICAL GYROSCOPE.

THE ordinary gyroscope is an instrument too well known to require more than a brief description.

It consists essentially of a wheel, with a heavy rim, whose axis turns very freely and accurately in bearings fixed to a frame. By giving a very rapid rotatory impulse to the wheel, in virtue of its heavy rim and its freedom of rotation on its axis, this motion will be sustained for some time, and under these conditions the arrangement possesses some peculiar properties. If the frame in which the wheel turns be itself suspended in a second moveable frame, so that the axis of the wheel is perfectly free to move and be set to any position, then, under ordinary conditions, that is when the wheel is not rotated, the position of the whole arrangement relatively to any fixed objects on the earth's surface will, of course, remain constant. If, however, the wheel have a rapid rotatory impulse given it, then if the axis of the wheel be pointed at any fixed object external to the earth—a fixed star for instance—the axis will continue to point in that direction, although the base of the instrument in which the frames turn be moved about to any position. The effect of gravity in tending to keep the wheel in a fixed position relative to the earth's surface, is in fact annihilated.

The utility of this instrument in showing the rotation of the earth is obvious, for, as the earth revolves, and the base of the instrument with it, the position of the rotatory wheel with reference to the objects on the earth's surface will alter, and the amount of the displacement will be proportional to the rate of the earth's rotation. Thus, if the axes were set normal to the earth's surface, an index hand fixed to the frame in which the wheel revolves, and pointing at right angles to the axes, would move over a divided circle attached to the

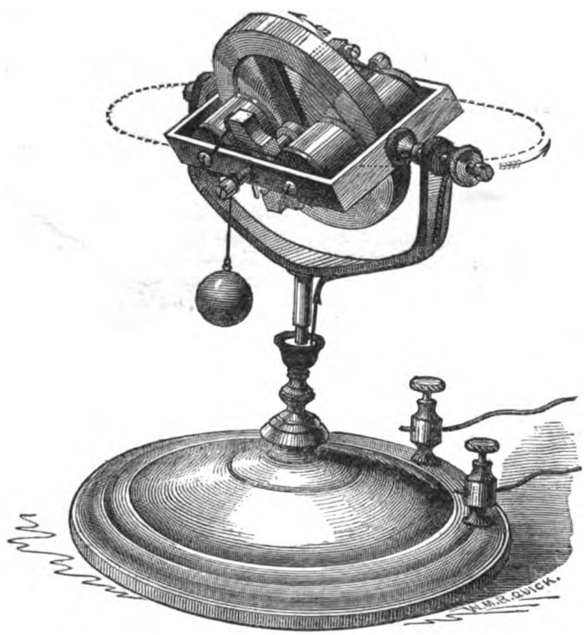
base of the instrument, with an angular velocity equal to 360° multiplied by the sine of the latitude of the locality where the instrument is placed, in 24 hours, that is, provided the suspensions of the frames turned quite free of friction, which is, of course, practically impossible; and in consequence of this friction, the arc through which the index hand would actually turn in 24 hours would be less than the number of degrees stated; but still the error need not be sufficient to vitiate the general result.

A most essential element in the working of the apparatus is the maintenance of the wheel in rapid rotation. However well pivotted the wheel and its axis may be, and however heavy the rim, no impulse given to the wheel will cause it to maintain its rotation for any considerable length of time. As it is absolutely necessary that any mechanism for maintaining the rotation form a part of the frame in which the wheel rotates, and be quite independent of any other parts, and moreover must not affect the balance of the frame, it is evident that any

The armature is arranged in such relation to the contact breaking spring and cylinder that, twice during each revolution, as the armature nears the magnet cores, it is attracted, but immediately the armature comes directly opposite the face of the magnets cores, the current is broken, and the acquired momentum is sufficient to carry the wheel forward until the armature is again within the influence of the magnet. In order to maintain continuity with the terminal screws on the base of the instrument, one connection is made through the metal framework, and the other by means of a wire dipping in a mercury cup.

Two or three Bunsen or bichromate cells are sufficient to maintain the rotation at the necessary velocity, and all the phenomena observable in the ordinary gyroscope can be repeated with great effect on this improved instrument.

We may observe that the rotation of the earth, although shown by the gyroscope, was first ocularly demonstrated by Foucault in 1852, by means of a pendulum, as it was noticed that the plane of oscilla-



clockwork arrangement turned by a heavy weight would be inadmissible. Mr. George M. Hopkins, of the United States, America, by rotating the wheel by electro-magnetism, has overcome this maintenance of rotation difficulty, and has thereby very considerably added to the value of the instrument. In fact, as far as can be seen, in consequence of this improvement of Mr. Hopkins, the gyroscope may prove a valuable scientific instrument, and not a mere toy as it has practically hitherto been.

The ordinary gyroscope as arranged with Mr. Hopkins' improvement is shown by the fig. The wheel, whose plane of rotation is at right angles with the magnet, carries a soft iron armature, which turns very near the face of the magnet, but does not touch it. An insulated contact breaking spring is arranged to touch a small cylinder on the wheel spindle twice during each rotation of the wheel.

tion of the latter remained fixed like the axis of the gyroscope. Like the gyroscope, it is essential that the movements of the pendulum be perfectly free, and to effect this Foucault formed his pendulum of a heavy ball, suspended by a long thin wire. Such an arrangement, although it answered the purpose of keeping up the oscillatory movement for several hours, is manifestly not one adapted for general purposes. The late Sir Charles Wheatstone devised an ingenious electrical arrangement by means of which the movements of a short pendulum freely suspended could be kept up for any length of time. His arrangement was as follows :—

The bob of the pendulum was an iron ball; this ball, when the pendulum was at rest, hung exactly over and close to the single pole of an electro-magnet, which we will call the pendulum electro-magnet. In this pole a slight cup-shaped

hollow was formed, in which a globule of mercury was placed. A needle point fixed to the lower part of the pendulum bob dipped into this globule and so formed an electrical communication between the wire, by which the bob was suspended and the iron core of the magnet; this connection was of course only made when the pendulum swung over the pole of the electro-magnet.

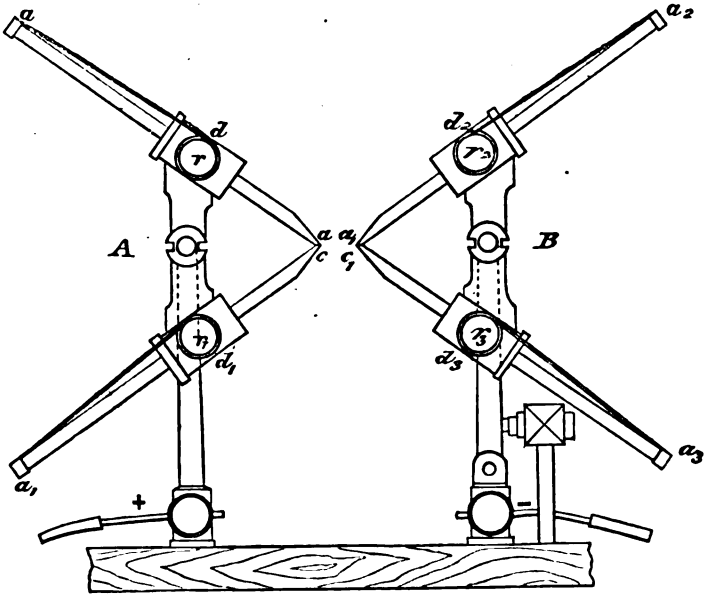
A battery kept a current flowing through this pendulum electro-magnet so long as the pendulum bob was on either side of the pole; consequently an attraction was exerted on the bob as it swung. Immediately the bob came over the pole of the magnet, and communication was set up through the globule of mercury, a current from a local battery flowed through a local electro-magnet through the medium of the iron core of the pendulum electro-magnet. The attraction of the armature of this electro-magnet broke the circuit of the pendulum electro-magnet, so that the attraction on the iron bob ceased, and the pendulum was free to swing towards the other limit of its course.

In order to prevent the circuit of the pendulum electro-magnet being completed immediately after the bob broke contact with the globule of mercury (as this would limit the arc of the swing to a very few degrees), the armature of the local electro-magnet did not make contact against a fixed contact screw, but against a slow turning fly of a train of clock-work; so that when the armature was attracted the fly was released, contact was broken, and this contact would not again be made, although the armature had been released by the pendulum bob swinging past the globule of mercury, until the fly had completely swung round and again come in contact with the armature.

RAPIEFF'S ELECTRIC LAMP.

This ingenious arrangement is shown by the fig.; its principle is as follows:—

Two sets of carbons a, c and a_1, c_1, which are set obliquely, meet with one another at their ends as shewn. These carbons are supported by and move longitudinally in tubes or slides d, d_1, d_2, d_3, fixed to the standards A and B. Springs or weights connected to the pulleys r, r_1, r_2, r_3 tend to press forward the carbons through the medium of cords attached to their ends a, a_1, a_2, a_3, so that the ends a, c and a_1, c_1, always remain in contact, however much they may be wasted by burning; moreover the locality of these points of contact always remains the same, and thus the distance between a, c and a_1, c_1, is always preserved constant.



By means of joints in the standards A and B the angle at which the carbons are inclined to one another can be altered if necessary. The distance between the two sets of points can be varied by sliding one of the stands forward or backwards.

In cases where sub-division of light is required, and several lamps have to be put in one and the same circuit, it is absolutely necessary that some arrangement be provided which will prevent the interruption of the circuit should one of the lamps fail and cause a disconnection. In order to effect this object, M. Rapieff provides two paths for the current to flow through at each lamp, one through the carbon points, and the other through a circuit which is interrupted the moment the current flows between the carbon points, but which is completed again should the current fail between them.

THE BRITISH ASSOCIATION.

WE hope the present number of our journal will appear in time to give those of our readers who intend to take part in the meeting of the British Association, now being held, information as to the means that have been provided for their accommodation, instruction, and recreation.

The journey to Ireland is most easy and convenient, thanks to the splendid mail-service between London and Dublin. By this route the whole journey is accomplished in less than twelve hours; by the London and North Western Company's boats the journey is quite as pleasant and much cheaper, though slightly longer. On landing, visitors will have no difficulty in finding accommodation, as, besides the generous hospitality so freely offered by Dublin residents, long lists of apartments have been prepared by the local committee, and most of the clubs have also opened their doors to members of the Association.

The proceedings of the Association begin on Wednesday, August 14th, with an evening lecture in the Exhibition Palace from Dr. Spottiswoode, the President-elect. Mr. Romane's discourse on "Animal Intelligence," and Professor Dewar's on "Dissociation; or, Modern Ideas of Chemical Action," on the evenings of August 16th and 19th, are given in the same building, which affords ample space for the numbers who are sure to attend these meetings. On Thursday the business proceedings of the week begin, the different sections meeting at eleven on that day in the various buildings assigned them in Trinity College. It is unusual to find such a convenient and central place of meeting in any town, and the fact that Dublin can find room for each section on one spot of ground should alone help to ensure the success of the present meeting. The Reception Committee have the large Examination Hall, near the entrance to Trinity College, which is also comfortably fitted up with chairs, tables, &c., for the use of members.

Thursday will prove a busy day, for, in addition to a garden-party and dinner given by the Lord-Lieutenant to the most distinguished members of the Association, a *soirée* is given in the evening by the Royal Dublin Society, for which most extensive preparations have been made, and which promises to be an entire success.

The splendid Museum will be thrown open for promenading, whilst the lawn in front will be electrically lighted. A powerful gas-engine and steam and water engines will be in action in a side hall, and amongst other exhibitions, will be an interesting display of carnivorous plants. Dr. Moss, of the Arctic expedition, has consented to discourse upon the extinct Irish deer, of which some remains were lately found near the Scalp, in the county Dublin, and will be on exhibition at the *soirée*. Members of one of the excursions will have an opportunity of seeing some of these remains *in situ*.

A phonograph has been lent by the London Stereoscopic Company, and many interesting pieces of apparatus from the South Kensington Museum, and the Loan Exhibition will also be exhibited. Amongst the electrical experiments, some with vacuum tubes are sure to prove attractive. A large induction coil, lent by Mr. Yates, and condenser of Mr. Spottiswoode's, are also included in the exhibits of this department.

Experiments will be conducted in another part of the building with the spectroscope and the polariscope, and to complete the variety of the entertainment, the Earl of Rosse has sent a beautifully fitted up telescope.

For Saturday an unusually complete and attractive list of excursions to the beautiful neighbourhood of Dublin has been published. The local papers give full programmes of these; we may just mention those to Brag Head, taking the Dargle and the Scalp on the way; to Howth and Ireland's Eye (interesting to botanists); for antiquarians, one to Malahide Castle and Swords; another by steamer to the points of interest around Dublin Bay; and finally, also by steamer, one to the lighthouses and light-ships in the Bay.

From the Howth Lighthouse, the electric light will be exhibited. Entertainment is offered to all joining these excursions by various resident noblemen.

The festivities of Monday commence with a breakfast given by the Royal Zoological Society in Phœnix Park; then, after the sectional meetings, comes a dinner at the College of Physicians, and a *conversazione* at the Royal College of Surgeons. The same evening Professor Dewar gives his lecture.

On Tuesday evening a *soirée* is given by the Royal Irish Academy, which promises to be of great interest, chiefly for the collection of ancient Irish manuscripts and remains that are contained in its museum. The oldest and most valuable manuscript is a copy, made by one of the abbots of Clonmacuoise, of a book composed in the seventh century. It is called the "Book of the Dun Cow," from the skin on which this copy was written, about the year 1100 A.D. Various other manuscripts, together with the library of the poet Moore, autograph copies of certain well-known poems, &c., are sure to interest the visitors.

The general committee meets finally on Wednesday, to select the next place of meeting, and on Thursday, again, delightful excursions are in prospect. Glendalough and the Seven Churches will attract antiquarians and lovers of beautiful scenery; but no less beautiful is the well-known Vale of Ovoca, Cashel, Kilkenny, Powerscourt, Curragh Camp, Boyne, the Varty Waterworks, and the Earl of Rosse's entertainment at Birr Castle. These excursions will surely satisfy the most exigeant of travellers. On Friday the members of the Association will have an opportunity of visiting the principal manufactories of Lisburn and Belfast. There is, thus, plenty of attraction of a non-scientific character for this week of meetings, and we anticipate a no less satisfactory scientific result. No papers of special interest are yet announced, but we may hope that to convince Englishmen of the cleverness and intellectual activity of their Irish neighbours, and to show Irishmen the real worth and desirability of scientific knowledge, will be no small achievement for the forty-eighth meeting of the British Association for the Advancement of Science and Art.

In our next we hope to give a general epitome of the meetings.

ADDRESS OF WILLIAM SPOTTISWOODE, Esq., M.A., D.C.L., LL.D., F.R.S., F.R.A.S., F.R.G.S., PRESIDENT.

On looking back at the long array of distinguished men who both in this and in the sister countries have filled the chair of the British Association; on considering also the increased pains which have been bestowed upon, and the increased importance attaching to, the Presidential Address; it may well happen when, as on this occasion, your choice has fallen upon one outside the sphere of professional Science, that your nominee should feel unusual diffidence in accepting the post. Two considerations have however in my own case outweighed all reasons for hesitation: First, the uniform kindness which I received at the hands of the Association throughout the eight years during which I had the honour of holding another office; and, secondly, the conviction that the same goodwill which was accorded to your Treasurer would be extended to your President.

These considerations have led me to arrange my observations under two heads, viz., I propose first to offer some remarks upon the purposes and prospects of the Association with which, through your suffrages, I have been so long and so agreeably connected; and, secondly, to indulge in a few reflexions, not indeed upon the details or technical progress, but upon the external aspects and tendencies of the Science which on this occasion I have the honour to represent. The former of these subjects is perhaps trite; but as an old man is allowed to become garrulous on his own hobby, so an old officer may be pardoned for lingering about a favourite theme. And although the latter may appear somewhat unpromising, I have decided to make it one of the topics of my discourse, from the consideration that the holder of this office will generally do better by giving utterance to what has already become part of his own thought, than by gathering matter outside of its habitual range for the special occasion. For, as it seems to me, the interest (if any) of an address consists, not so much in the multitude of things therein brought forward, as in the individuality of the mode in which they are treated.

The British Association has already entered its fifth decade. It has helds its meetings, this the 48th, in twenty-eight different towns. In six cities of note, viz., York, Bristol, Newcastle-on-Tyne, Plymouth, Manchester, and Belfast, its curve of progress may be said to have a node, or point through which it has twice passed; in the five Universities of Oxford, Cambridge, Dublin, Edinburgh, and Glasgow, and in the two great commercial centres, Liverpool and Birmingham, it may similarly be said to have a triple point, or one through which it has three times passed. Of our forty-six Presidents more than half (twenty-six, in fact) have passed away; while the remainder hold important posts in Science, and in the Public Service, or in other avocations not less honourable in themselves, nor less useful to the commonwealth. And whether it be due to the salubrity of the climate or to the calm and dispassionate spirit in which Science is pursued by its votaries here, I do not pretend to say; but it is a fact that the earliest of our ex-Presidents still living, himself one of the original members of the Association, is a native of and resident in this country.

At both of our former meetings held in Dublin, in 1835, and 1857 respectively, while greatly indebted to the liberal hospitality of the citizens at large, we were, as we now are, under especial obligations to the authorities of Trinity College for placing at our disposal buildings, not only unusually spacious and convenient in themselves, but full of reminiscences calculated to awake the scientific sympathies of all who may be gathered in them. At both of those former Dublin meetings the venerable name of Lloyd figured at our head; and if long-established custom had not seemed to preclude it, I could on many accounts have wished that we had met for a third time under the same name. And although other distinguished men, such as Dr. Robinson, Professors Stokes, Tyndall, and Andrews, are similarly disqualified by having already passed the Presidental chair, while others again, such as Sir W. R. Hamilton, Dr. M'Cullagh, and Professor Jukes, are permanently lost to our ranks; still we should not have had far to seek, had we looked for a President in this fertile island itself. But as every one connected with the place of meeting partakes of the character of host towards ourselves as guests, it has been thought by our oldest and most experienced members that we should better respond to an invitation by bringing with us a President to speak as our representative than by seeking one on the spot; and we may always hope on subsequent occasions that some of our present hosts may respond to a similar call.

But leaving our past history, which will form a theme more appropriate to our jubilee meeting in 1881, at the ancient City of York, I will ask your attention to a few particulars of our actual operations.

Time was when the Royal Societies of London and Edinburgh and the Royal Irish Academy were the only representative bodies of British Science and the only receptacles of memoirs relating thereto. But latterly the division of labour, so general in industrial life, has operated in giving rise to special societies, such as the Astronomical, the Linnæan, the Chemical, the Geological, the Geographical, the Statistical, the Mathematical, the Physical, and many others. To both the earlier, or more general, and the later or more special societies alike, the British Association shows resemblance and affinity. We are general in our comprehensiveness; we are special in our sectional arrangement; and in this respect we offer not only a counterpart, but to some extent a counterpoise, to the general tendency to sub-division in science. Further still, while maintaining in their integrity all the elements of a strictly scientific body, we also include, in our character of a microcosm, and under our more social aspect, a certain freedom of treatment, and interaction of our various branches, which is scarcely possible among separate and independent societies.

The general business of our meetings consists, first, in receiving and discussing communications upon scientific subjects at the various sections into which our body is divided, with discussions thereon; secondly, in distributing, under the advice of our Committee of Recommendations, the funds arising from the subscriptions of members and associates; and thirdly, in electing a council upon whom devolves the conduct of our affairs until the next meeting.

The communications to the sections are of two kinds, viz., papers from individuals, and reports from committees.

As to the subject-matter of the papers, nothing which falls within the range of natural knowledge, as partitioned among our sections, can be considered foreign to the purposes of the Association; and even many applications of science, when viewed in reference to their scientific bases, may properly find a place in our proceedings. So numerous, however, are the topics herein comprised, so easy the transition beyond these limits, that it has been thought necessary to confine ourselves strictly within this range, lest the introduction of other matters, however interesting to individual members, should lead to the sacrifice of more important subjects. As to the form of the communications, while it is quite true that every scientific conclusion should

be based upon substantial evidence, every theory complete before being submitted for final adoption, it is not the less desirable that even tentative conclusions and hypothetical principles when supported by sufficient *primâ facie* evidence, and enunciated in such a manner as to be clearly apprehended, should find room for discussion at our sectional meetings. Considering, however, our limitations of time, and the varied nature of our audience, it would seem not inappropriate to suspend, mentally if not materially, over the doors of our section rooms, the Frenchman's dictum, that no scientific theory "can be considered complete until it is so clear that it can be explained to the first man you meet in the street."

Among the communications to the Sections, undoubtedly the most important, as a rule, are the Reports; that is to say, documents issuing from specially apppointed Committees, some of which have been recipients of the grants mentioned above. These Reports are in the main of two kinds, first, accounts of observations carried on for a series of years, and intended as records of information on the special subjects; such for instance have been those made by the Kew Committee, by the Committees on Luminous Meteors, on British Rainfall, on the Speed of Steamships, on Underground Temperature, on the Exploration of certain Geological Caverns, &c. These investigations, frequently originating in the energy and special qualifications of an individual, but conducted under the control of a Committee, have in many cases been continued from year to year, until either the object has been fully attained, or the matter has passed into the hands of other bodies, which have thus been led to recognise an inquiry into these subjects as part and parcel of their appropriate functions. The second class is one which is perhaps even more peculiar to the Association; viz., the Reports on the progress and present state of some main topics of Science. Among these may be instanced the early Reports on Astronomy, on Optics, on the Progress of Analysis; and later, those on Electrical Resistance, and on Tides; that of Prof. G. G. Stokes on Double Refraction; that of Prof. H. J. Smith on the Theory of Numbers; that of Mr. Russell on Hyperelliptic Transcendents; and others. On this head Prof. Carey Foster, in his address to the Mathematical and Physical Section at our meeting last year, made some excellent recommendations, to which, however, I need not at present more particularly refer, as the result of them will be duly laid before the section in the form of the report from a committee to whom they were referred. It will be sufficient here to add that the wide extension of the sciences in almost every branch, and the consequent specialisation of the studies of each individual, have rendered the need for such reports more than ever pressing; and if the course of true science should still run smooth, it is probable that the need will increase rather than diminish.

If time and space had permitted, I should have further particularised the committees occasionally appointed on subjects connected with education. But I must leave this theme for some future president, and content myself with pointing out that the British Association alone among scientific societies concerns itself directly with these questions, and is open to appeals for counsel and support from the great teaching body of the country.

One of the principal methods by which this Association materially promotes the advancement of science, and consequently one of its most important functions, consists in grants of money from its own income in aid of special scientific researches. The total amount so laid out during the forty-seven years of our existence has been no less than £44,000; and the average during the last ten years has been £1,450 per annum. These sums have not only been in the main wisely voted and usefully expended; but they have been themselves productive of much additional voluntary expenditure of both time and money on the part of those to whom the grants have been entrusted. The results have come back to the Association in the form of papers and reports, many of which have been printed in our volumes. By this appropriation of a large portion of its funds, the Association has to some extent anticipated, nay even it may have partly inspired the ideas, now so much discussed, of the Endowment of Research. And whether the aspirations of those who advocate such endowment be ever fully realised or not, there can I think be no doubt whatever that the Association in the matter of these grants has afforded a most powerful stimulus to original research and discovery.

Regarded from another point of view these grants, together with others to be hereafter mentioned, present a strong similarity to that useful institution, the Professoriate Extraordinary of Germany, to which there are no foundations exactly corresponding in this country. For, beside their more direct educational purpose, these Professorships are intended, like our own grants, to afford to special individuals an opportunity of following out the special work for which they have previously proved themselves competent. And in this respect the British Association may be regarded as supplying to the extent of its means, an elasticity which is wanting in our own Universities.

Besides the funds which through your support are at the disposal of the British Association there are, as is well known to many here present, other funds of more or less similar character, at the disposal or subject to the recommendations of the Royal Society. There is the Donation Fund, the property of the Society; the Government Grant of £1,000 per annum, administered by the Society; and the Government Fund of £4,000 per annum (an experiment for five years) to be distributed by the Science and Art Department, both for research itself, and for the support of those engaged thereon, according to the recommendations of a Committee consisting mainly of Fellows of the Royal Society. To these might be added other funds in the hands of different Scientific Societies.

But although it must be admitted that the purposes of these various funds are not to be distinguished by any very simple line of demarcation, and that they may therefore occasionally appear to overlap one another, it may still, I think be fairly maintained that this fact does not furnish any sufficient reason against their co-existence. There are many topics of research too minute in their range, too tentative in their present condition, to come fairly within the scope of the funds administered by the Royal Society. There are others, ample enough in their necessary duration, to claim for their support a national grant, but which need to be actually set on foot or tried before they can fairly expect the recognition either of the public or of the Government. To these categories others might be added; but the above-mentioned instances will perhaps suffice to show that even if larger and more permanent funds were devoted to the promotion of research than is the case at present, there would still be a field of activity open to the British Association as well as to other scientific bodies which may have funds at their disposal.

On the general question it is not difficult to offer strong arguments in favour of permanent national Scientific Institutions; nor is it difficult to picture to the mind an ideal future when Science and Art shall walk hand in hand together, led by a willing minister into the green pastures of the Endowment of Research. But while allowing this to be no impossible a future,

we must still admit that there are other and less promising possibilities, which under existing circumstances cannot be altogether be left out of our calculations. I am therefore on the whole inclined to think that, while not losing sight of larger schemes, the wisest policy, for the present at all events, and pending the experiment of the Government fund, will be to confine our efforts to a careful selection of definite persons to carry out definite pieces of work; leaving to them the honour (or the onus if they so think it) of justifying from time to time a continuation of the confidence which the Government or other supporting body may have once placed in them.

Passing from the proceedings to other features and functions of our body, it should be remembered that the continued existence of the Association must depend largely upon the support which it receives from its members and associates. Stinted in the funds so arising, its scientific effectiveness would be materially impaired; and deprived of them, its existence would be precarious. The amount at our disposal in each year will naturally vary with the population, with the accessibility, and with other circumstances of the place of meeting; there will be financially, as well as scientifically, good years and bad years. But we have in our invested capital a sum sufficient to tide over all probable fluctuations, and even to carry us efficiently through several years of financial famine, if ever such should occur. This seems to me sufficient; and we have therefore, I think, no need to increase our reserve, beyond perhaps the moderate addition which a prudent treasurer will always try to secure, against expenditure which often increases and rarely diminishes.

But however important this material support may be to our existence and well being, it is by no means all that is required. There is another factor which enters into the product, namely, the personal scientific support of our best men. It is, I think, not too much to say, that without their presence our meetings would fail in their chief and most important element, and had best be discontinued altogether. We make, it must be admitted, a demand of sensible magnitude in calling upon men who have been actively engaged during a great portion of the year, at a season when they may fairly look for relaxation, to attend a busy meeting, and to contribute to its proceedings; but unless a fair quota at least of our veterans, and a good muster of our younger men, put in their appearance, our gatherings will be to little purpose. There was a period within my own recollection when it was uncertain whether the then younger members of our scientific growth would cast in their lot with us or not, and when the fate of the Association depended very much upon their decision. They decided in our favour; they have since become Presidents, Lecturers, and other functionaries of our body; with what result it is for you to judge.

Of the advantages which may possibly accrue to the locality in which our meetings are held, it is not for us to speak; but it is always a ground for sincere satisfaction to learn that our presence has been of any use in stimulating an interest, or in promoting local efforts, in the direction of Science.

The functions of the British Association do not, however, terminate with the meeting itself. Beside the special committees already mentioned, there remains a very important body, elected by the General Committee, viz., the Council, which assembles at the office in London from time to time as occasion requires. To this body belongs the duty of proposing a President, of preparing for the approval of the General Committee the list of Vice-Presidents and sectional officers, the selection of evening lecturers, and other arrangements for the coming meeting.

At the present time another class of questions occupies a good deal of the attention of the Council. In the first generation of the Association, and during the period of unwritten, but not yet traditional, law, questions relating to our own organisation or procedure either "settled themselves," or were wisely left to the discretionary powers of those who had taken part in our proceedings during the early years of our existence. These and other kindred subjects now require more careful formularisation and more deliberate sanction. And it is on the shoulders of the Council that the weight of these matters in general falls. These facts deserve especial mention on the present occasion, because one part of our business at the close of this meeting will be to bid farewell officially to one who has served us as Assistant Secretary so long and so assiduously that he has latterly become our main repertory of information, and our mentor upon questions of precedent and procedure. The post hitherto held by Mr. Griffith (for it is to him that I allude) will doubtless be well filled by the able and energetic member who has been nominated in his place; but I doubt that even he will be glad for some time to come to draw largely upon the knowledge and experience of his predecessor.

But, beside matters of internal arrangement and organisation, the duties of the Council comprise a variety of scientific subjects referred to them by the General Committees, at the instance of the Committee of Recommendations, for deliberation and occasionally for action. With the increasing activity of our body in general, and more particularly with that of our various officers, these duties have of late years become more varied and onerous than formerly; nor is it to be wished that they should diminish in either variety or extent.

Once more, questions beyond our own constitution, and even beyond the scope of our own immediate action, such as education, legislation affecting either the promotion or the applications of science to industrial and social life, which have suggested themselves at our meetings, and received the preliminary sanction of our Committee of of Recommendations, are frequently referred to our Council. These, and others which it is unnecessary to particularise, whether discussed in full Council or in committees specially appointed by that body, render the duties of our councillors as onerous as they are important.

While the Government has at all times, but in a more marked manner of late years, recognised the Royal Society of London, with representatives from the sister societies of Dublin and of Edinburgh, as the body to which it should look for counsel and advice upon scientific questions, it has still never shown itself indisposed to receive and entertain any well-considered recommendation from the British Association. Two special causes have in all probability contributed largely to this result. First, the variety of elements comprised by the Association, on account of which its recommendations imply a more general concurrence of scientific opinion than those of any other scientific body. Secondly, the peculiar fact, that our period of maximum activity coincides with that of minimum activity of other scientific bodies, is often of the highest importance. At the very time when the other bodies are least able, we are most able, to give deliberate consideration, and formal sanction, to recommendations whether in the form of applications to Government or otherwise which may arise. In many of these, time is an element so essential, that it is not too much to say, that without the intervention of the British Association many opportunities for the advancement of Science, especially at the seasons in question, might have been lost. The Government has moreover formally recognised our scientific existence by appointing our President for the time being a member of the Government Fund Committee; and the public has added its

testimony to our importance and utility by imposing upon our President and officers a variety of duties, among which are conspicuous those which arise out of its very liberal exercise of civic and other hospitality.

Of the nature and functions of the Presidential address this is perhaps neither the time nor the place to speak; but if I might for a moment forget the purpose for which we are now assembled, I would take the opportunity of reminding those who have not attended many of our former meetings that our annual volumes contain a long series of addresses on the progress of Science, from a number of our most eminent men, to which there is perhaps no parallel elsewhere. These addresses are perhaps as remarkable for their variety in mode of treatment as for the value of their subject-matter. Some of our Presidents, and especially those who officiated in the earlier days of our existence, have passed in review the various branches of Science, and have noted the progress made in each during the current year. But, as the various Sciences have demanded more and more special treatment on the part of those who seriously pursue them, so have the cases of individuals who can of their own knowledge give anything approaching to a general review become more and more rare. To this may be added the fact that although no year is so barren as to fail in affording sufficient crop for a strictly scientific budget, or for a detailed report of progress in research, yet one year is more fertile than another in growths of sufficient prominence to arrest the attention of the general public, and to supply topics suitable for the address. On these accounts apparently such a Presidential survey has ceased to be annual, and has dropped into an intermittence of longer period. Some Presidents have made a scientific principle, such as the Time-element in natural phenomena, or Continuity, or Natural Selection, the theme of their discourse, and have gathered illustrations from various branches of knowledge. Others again, taking their own special subject as a fundamental note, and thence modulating into other kindred keys, have borne testimony to the fact that no subject is so special as to be devoid of bearing or of influence on many others. Some have described the successive stages of even a single but important investigation; and while tracing the growth of that particular item, and of the ideas involved in it, have incidentally shown to the outer world what manner of business a serious investigation is. But there is happily no pattern or precedent which the President is bound to follow; both in range of subject-matter and in mode of treatment each has exercised his undoubted right of taking an independent line. And it can hardly be doubted that a judicious exercise of this freedom has contributed more than anything else to sustain the interest of a series of annual discourses extending now over nearly half a century.

The nature of the subjects which may fairly come within the scope of such a discourse has of late been much discussed; and the question is one upon which everyone of course is entitled to form his own judgment; but lest there should be any misapprehension as to how far it concerns us in our corporate capacity, it will be well to remind my hearers that as, on the one hand, there is no discussion on the Presidential address, and the members as a body express no formal opinion upon it, so, on the other, the Association cannot fairly be considered as in any way committed to its tenour or conclusions. Whether this immunity from comment and reply be really on the whole so advantageous to the President as might be supposed need not here be discussed; but suffice it to say that the case of an audience assembled to listen without discussion finds a parallel elsewhere, and in the parallel case it is not generally considered that the result is altogether either advantageous to the speaker or conducive to excellence in the discourse.

But, apart from this, the question of a limitation of range in the subject-matter for the Presidental address is not quite so simple as may at first sight appear. It must, in fact, be born in mind that, while on the one hand knowledge is distinct from opinion, from feeling, and from all other modes of suggestive impression, still the limits of knowledge are at all times expanding, and the boundaries of the known and the unknown are never rigid or permanently fixed. That which in time past or present has be longed to one category may in time future belong to the other. Our ignorance consists partly in ignorance of actual facts, and partly also in ignorance of the possible range of ascertainable fact. If we could lay down beforehand precise limits of possible knowledge, the problem of Physical Science would be already half solved. But the question to which the scientific explorer has often to address himself is not merely whether he is able to solve this or that problem, but whether he can so far unravel the tangled threads of the matter with which he has to deal as to weave them into a definite problem at all. He is not like a candidate at an examination with a precise set of questions placed before him; he must first himself act the part of the examiner and select questions from the repertory of nature, and upon them found others, which in some sense are capable of definite solution. If his eyes seem dim, he must look steadfastly and with hope into the misty vision, until the very clouds wreath themselves into definite forms. If his ear seem dull, he must listen patiently and with sympathetic trust to the intricate whisperings of nature—the goddess, as she has been called, of a hundred voices—until here and there he can pick out a few simple notes to which his own powers can resound. If, then, at a moment when he finds himself placed on a pinnacle from which he is called upon to take a perspective survey of the range of science, and to tell us what he can see from his vantage ground; if, at such a moment, after straining his gaze to the very verge of the horizon, and after describing the more distant of well-defined objects, he should give utterance also to some of the subjective impressions which he is conscious of receiving from regions beyond; if he should depict possibilities which seem opening to his view; if he should explain why he thinks this a mere blind alley and that an open path; then the fault and the loss would be alike ours if we refused to listen calmly, and temperately to form our own judgment on what we hear; then assuredly it is we who would be committing the error of confounding matters of fact and matters of opinion if we failed to discriminate between the various elements contained in such a discourse, and assumed that they had all been put on the same footing.

But to whatever decision we may each come on these controverted points, one thing appears clear from a retrospect of past experience, viz., that first or last, either at the ouset in his choice of subject or in the conclusions ultimately drawn therefrom, the President, according to his own account at least, finds himself on every occcasion in a position of "exceptional or more than usual difficulty." And your present representative, like his predecessors, feels himself this moment in a similar predicament. The reason which he now offers is that the branch of science which he represents is one whose lines of advance, viewed from a mathematician's own point of view, offer so few points of contact with the ordinary experiences of life or modes of thought, that any account of its actual progress which he might have attempted must have failed in the first requisite of an address, namely, that of being intelligible.

Now if this esoteric view had been the only aspect of the subject which he could present to his hearers, he might well have given up the attempt in despair. But although in its technical character mathematical science suffers the inconveniences, while it enjoys the dignity, of its Olympian position, still in a less formal garb, or in disguise, if you are pleased so to call it, it is found present at many an unexpected turn; and although some of us may never

have learnt its special language, not a few have, all through our scientific life, and even in almost every accurate utterance, like Moliére's well known character, been talking mathematics without knowing it. It is, moreover, a fact not to be overlooked that the appearance of isolation, so conspicuous in mathematics, appertains in a greater or less degree to all other sciences, and perhaps also to all pursuits in life. In its highest flight each soars to a distance from its fellows. Each is pursued alone for its own sake, and without reference to its connection with, or its application to, any other subject. The pioneer and the advanced guard are of necessity separated from the main body, and in this respect mathematics does not materially differ from its neighbours. And, therefore, as the solitariness of mathematics has been a frequent theme of discourse, it may be not altogether unprofitable to dwell for a short time upon the other side of the question, and to inquire whether there be not points of contact in method or in subject-matter between mathematics and the outer world which have been frequently overlooked; whether its lines do not in some cases run parallel to those of other occupations and purposes of life; and lastly, whether we may not hope for some change in the attitude too often assumed towards it by the representatives of other branches of knowledge and of mental activity.

In his Preface to the "Principia" Newton gives expression to some general ideas which may well serve as the key-note for all future utterances on the relation of mathematics to natural, including also therein what are commonly called artificial, phenomena.

"The ancients divided mechanics into two parts, rational and practical; and since artizans often work inaccurately, it came to pass that mechanics and geometry were distinguished in this way, that everything accurate was referred to geometry, and everything inaccurate to mechanics. But the inaccuracies appertain to the artizan and not to the art, and geometry itself has its foundation in mechanical practice, and is in fact nothing else than that part of universal mechanics which accurately lays down and demonstrates the art of measuring." He next explains that rational mechanics is the science of motion resulting from forces, and adds, "The whole difficulty of philosophy seems to me to lie in investigating the forces of nature from the phenomena of motion, and in demonstrating that from these forces other phenomena will ensue." Then, after stating the problems of which he has treated in the work itself, he says, "I would that all other natural phenomena might similiarly be deduced from mechanical principles. For many things move me to suspect that everything depends upon certain forces in virtue of which the particles of bodies, through forces not yet understood, are either impelled together so as to cohere in regular figures, or are repelled and recede from one another."

Newton's views, then, are clear. He regards mathematics, not as a method independent of, though applicable to, various subjects, but as itself the higher side or aspect of the subjects themselves; and it would be little more than a translation of his notions into other language, little more than a paraphrase of his own words, if we were to describe the mathematical as one aspect of the material world itself, apart from which all other aspects are but incomplete sketches, and, however accurate after their own kind, are still liable to the imperfections of the inaccurate artificer. Mr. Burrowes, in his preface to the first volume of the "Transactions of the Royal Irish Academy," has carried out the same argument approaching it from the other side. "No one science," he says, "is so little connected with the rest as not to afford many principles whose use may extend considerably beyond the science to which they primarily belong, and no proposition is so purely theoretical as to be incapable of being applied to practical purposes. There is no apparent connection between duration and the cycloidal arch, the properties of which have furnished us with the best method of measuring time; and he who has made himself master of the nature and affections of the logarithmic curve has advanced considerably towards ascertaining the proportionable density of the air at various distances from the earth. The researches of the mathematician are the only sure ground on which we can reason from experiments; and how far experimental science may assist commercial interests is evinced by the success of manufacturers in countries where the hand of the artificer has taken its direction from the philosopher. Every manufacture is in reality but a chemical process, and the machinery requisite for carrying it on but the right application of certain propositions in rational mechanics." So far your Academician. Every subject, therefore, whether in its usual acceptation, scientific, or otherwise, may have a mathematical aspect; as soon, in fact, as it becomes a matter of strict measurement, or of numerical statement, so soon does it enter upon a mathematical phase. This phase may, or it may not, be a prelude to another in which the laws of the subject are expressed in algebraical formulæ or represented by geometrical figures. But the real gist of the business does not always lie in the mode of expression, and the fascination of the formulæ or other mathematical paraphernalia may, after all, be a little more than that of a theatrical transformation scene. The process of reducing to formulæ is really one of abstraction, the results of which are not always wholly on the side of gain; in fact, through the process itself the subject may loose in one respect even more than it gains in another. But long before such abstraction is completely attained, and even in cases where it is never attained at all, a subject may to all intents and purposes become mathematical. It is not so much elaborate calculations or abstruse processes which characterise this phrase as the principles of precision, of exactness, and of proportion. But these are principles with which no true knowledge can entirely dispense. If it be the general scientific spirit which at the outset moves upon the face of the waters, and out of the unknown depth brings forth light and living forms, it is no less the mathematical spirit which breathes the breath of life into what would otherwise have ever remained dry bones of fact, which reunites the scattered limbs and re-creates from them a new and organic whole.

And as a matter of fact, in the words used by Professor Jellett at our meeting at Belfast, viz., "Not only are we applying our methods to many sciences already recognised as belonging to the legitimate province of mathematics, but we are learning to apply the same instrument to sciences hitherto wholly or partially independent of its authority. Physical science is learning more and more every day to see in the phenomena of Nature modifications of that one phenomenon (namely, Motion) which is peculiarly under the power of mathematics." Echoes are these, far off and faint perhaps, but still true echoes, in answer to Newton's wish that all these phenomena may some day "be deduced from mechanical principles."

If, turning from this aspect of the subject it were my purpose to enumerate how the same tendency has evinced itself in the Arts, unconsciously it may be to the artists themselves, I might call as witnesses each one in turn with full reliance on the testimony which they would bear. And, having more special reference to mathematics, I might confidently point to the accuracy of measurement, to the truth of curve, which according to modern investigation is the key to the perfection of classic art. I might triumphantly cite not only the architects of all ages, whose art so manifestly rests upon mathematical principles; but I might cite also the literary as well as the artistic remains of the great artists of Cinquecento, both painters and sculptors, in evidence of the geometry and the mechanics which, having been laid at the foundation, appear to have found their way upwards through the superstructure of their works. And in a less ambitious

sphere, but nearer to ourselves in both time and place, I might point with satisfaction to the great school of English constructors of the 18th century in the domestic arts; and remind you that not only the engineer and the architect, but even the cabinet makers devoted half the space of their books to perspective and to the principles whereby solid figures may be delineated on paper, or what is now termed descriptive geometry.

Nor perhaps would the sciences which concern themselves with reasoning and speech, nor the kindred art of music, nor even literature itself, if thoroughly probed, offer fewer points of dependence upon the science of which I am speaking. What, in fact, is logic but that part of universal reasoning; grammar but that part of universal speech; harmony and counterpoint but that part of universal music, "which accurately lays down," and demonstrates (so far as demonstration is possible) precise methods appertaining to each of these arts? And I might even appeal to the common consent which speaks of the mathematical as the pattern form of reasoning and model of a precise style.

Taking, then, precision and exactness as the characteristics which distinguish the mathematical phase of a subject, we are naturally led to expect that the approach to such a phase will be indicated by increasing application of the principle of measurement, and by the importance which is attached to numerical results. And this very necessary condition for progress may, I think, be fairly described as one of the main features of scientific advance in the present day.

If it were my purpose, by descending into the arena of special sciences, to show how the most various investigations alike tend to issue in measurement, and to that extent to assume a mathematical phase, I should be embarrassed by the abundance of instances which might be adduced. I will therefore confine myself to a passing notice of a very few, selecting those which exemplify not only the general tendency, but also the special character of the measurements now particularly required, viz., that of minuteness, and the indirect method by which alone we can at present hope to approach them. An object having a diameter of an 80,000th of an inch is perhaps the smallest of which the microscope could give any well-defined representation; and it is improbable that one of 120,000th of an inch could be singly discerned with the highest powers at our command. But the solar beams and the electric light reveal to us the presence of bodies far smaller than these. And, in the absence of any means of observing them singly, Professor Tyndall has suggested a scale of these minute objects in terms of the lengths of luminiferous waves. To this he was led, not by any attempt at individual measurement, but by taking account of them in the aggregate, and observing the tints which they scatter laterally when clustered in the form of actinic clouds. The small bodies with which experimental Science has recently come into contact are not confined to gaseous molecules, but comprise also complete organisms; and the same philosopher has made a profound study of the momentous influence exerted by these minute organisms in the economy of life. And if, in view of their specific effects, whether deleterious or other, on human life, any qualitative classification, or quantitative estimate be ever possible, it seems that it must be effected by some such method as that indicated above.

Again, to enumerate a few more instances of the measurement of minute quantities, there are the average distances of molecules from one another in various gases and at various pressures; the length of their free path, or range open for their motion without coming into collision; there are movements causing the pressures and differences of pressure under which Mr. Crookes' radiometers execute their wonderful revolutions. There are the excursions of the air while transmitting notes of high pitch, which, through the researches of Lord Rayleigh, appear to be of a diminutiveness altogether unexpected. There are the molecular actions brought into play in the remarkable experiments by Dr. Kerr, who has succeeded, where even Faraday failed, in effecting a visible rotation of the plane of polarisation of light in its passage through electrified dielectries, and on its reflection at the surface of a magnet. To take one more instance, which must be present to the minds of us all, there are the infinitesimal ripples of the vibrating plate in Mr. Graham Bell's most marvellous invention. Of the nodes and ventral segments in the plate of the telephone which actually converts sound into electricity and electricity into sounds, we can at present form no conception. All that can now be said is that the most perfect specimens of Chladni's sand figures on a vibrating plate, or of Kundt's lycopodium heaps in a musical tube, or even Mr. Sedley Taylor's more delicate vortices in the films of the Phoneidoscope, are rough and sketchy compared with these. For notwithstanding the fact that in the movements of the telephone-plate we have actually in our hand the solution of that old world problem, the construction of a speaking machine; yet the characters in which that solution is expressed are too small for our powers of decipherment. In movements such as these we seem to lose sight of the distinction, or perhaps we have unconsciously passed the boundary between massive and molecular motion.

Through the Phonograph we have not only a transformation but a permanent and tangible record of the mechanism of speech. But the differences upon which articulation (apart from loudness, pitch, and quality) depends, appear from the experiments of Fleeming Jenkin and of others to be of microscopic size. The microphone affords another instance of the unexpected value of minute variations—in this case of electric currents; and it is remarkable that the gist of the instrument seems to lie in obtaining and perfecting that which electricians have hitherto most scrupulously avoided, viz., loose contact.

Once more, Mr. De La Rue has brought forward as one of the results derived from his stupendous battery of 10,000 cells, strong evidence for supposing that a voltaic discharge, even when apparently continuous, may still be an intermittent phenomenon; but all that is known of the period of such intermittence is, that it must recur at exceedingly short intervals. And in connection with this subject, it may be added that, whatever be the ultimate explanation of the strange stratification which the voltaic discharge undergoes in rarefied gases, it is clear that the alternate disposition of light and darkness must be dependent on some periodic distribution in space or sequence in time which can at present be dealt with only in a very general way. In the exhausted column we have a vehicle for electricity not constant like an ordinary conductor, but itself modified by the passage of the discharge, and perhaps subject to laws differing materially from those which it obeys at atmospheric pressure. It may also be that some of the features accompanying stratification form a magnified image of phenomena belonging to disruptive discharges in general; and that consequently, so far from expecting among the known facts of the latter any clue to an explanation of the former, we must hope ultimately to find in the former an elucidation of what is at present obscure in the latter. A prudent philosopher usually avoids hazarding any forecast of the practical application of a purely scientific research. But it would seem that the configuration of these striæ might some day prove a very delicate means of estimating low pressures, and perhaps also for effecting some electrical measurements.

Now, it is a curious fact that almost the only small quantities of which we have as yet any actual measurements are the wave lengths of light; and that all others excepting so far as they can be deduced from these, await future determination. In the meantime, when

unable to approach these small quantities individually, the method to which we are obliged to have recourse is, as indicated above, that of averages, whereby, disregarding the circumstances of each particular case, we calculate the average size, the average velocity, the average direction, &c., of a large number of instances. But although this method is based upon experience, and leads to results which may be accepted as substantially true; although it may be applicable to any finite interval of time, or over any finite area of space (that is, for all practical purposes of life), there is no evidence to show that it is so when the dimensions of interval or of area are indefinitely diminished. The truth is that the simplicity of nature which we at present grasp is really the result of infinite complexity; and that below the uniformity there underlies a diversity whose depths we have not yet probed, and whose secret places are still beyond our reach.

The present is not an occasion for multiplying illustrations, but I can hardly omit a passing allusion to one all-important instance of the application of the statistical method. Without its aid social life, or the History of Life and Death, could not be conceived at all, or only in the most superficial manner. Without it we could never attain to any clear ideas of the condition of the Poor, we could never hope for any solid amelioration of their condition or prospects. Without its aid, sanitary measures, and even medicine, would be powerless. Without it, the politician and the philanthropist would alike be wandering over a trackless desert.

It is, however, not so much from the side of Science at large as from that of Mathematics itself, that I desire to speak. I wish from the latter point of view to indicate connections between Mathematics and other subjects, to prove that hers is not after all such a far-off region, nor so undecipherable an alphabet, and to show that even at unlikely spots we may trace under-currents of thought which having issued from a common source fertilise alike the mathematical and the non-mathematical world.

Having this in view, I propose to make the subject of special remark some processes peculiar to Modern Mathematics; and, partly with the object of incidentally removing some current misapprehensions, I have selected for examination three methods in respect of which mathematicians are often thought to have exceeded all reasonable limits of speculation, and to have adopted for unknown purposes an unknown tongue. And it will be my endeavour to show not only that in these very cases our science has not outstepped its own legitimate range, but that even art and literature have unconsciously employed methods similar in principle. The three methods in question are, first, that of Imaginary Quantities; secondly, that of Manifold Space; and thirdly, that of Geometry not according to Euclid.

First it is objected that, abandoning the more cautious methods of ancient mathematicians, we have admitted into our formulæ quantities which by our own showing, and even in our own nomenclature, are imaginary or impossible; nay, more, that out of them we have formed a variety of new algebras to which there is no counterpart whatever in reality; but from which we claim to arrive at possible and certain results.

On this head it is in Dublin, if anywhere, that I may be permitted to speak. For to the fertile imagination of the late Astronomer-Royal for Ireland we are indebted for that marvellous Calculus of Quaterdions, which is only now beginning to be fully understood, and which has not yet received all the applications of which it is doubtless capable. And even although this calculus be not co-extensive with another which almost simultaneously germinated on the Continent, nor with ideas more recently developed in America; yet it must always hold its position as an original discovery, and as a representative of one of the two great groups of generalised algebras (viz., those the squares of whose units are respectively negative unity and zero), the common origin of which must still be marked on our intellectual map as an unknown region. Well do I recollect how in its early days we used to handle the method as a magician's page might try to wield his master's wand, trembling as it were between hope and fear, and hardly knowing whether to trust our own results until they had been submitted to the present and ever-ready counsel of Sir W. R. Hamilton himself.

To fix our ideas, consider the measurement of a line, or the reckoning of time, or the performance of any mathematical operation. A line may be measured in one direction or the opposite; time may be reckoned forward or backward; an operation may be performed or be reversed, it may be done or may be undone; and if having once reversed any of these processes we reverse it a second time, we shall find that we have come back to the original direction of measurement or of reckoning, or to the original kind of operation.

Suppose, however, that at some stage of a calculation our formulæ indicate an alteration in the mode of measurement such that, if the alteration be repeated, a condition of things, not the same as, but the reverse of the original, will be produced. Or suppose that, at a certain stage, our transformations indicate that time is to be reckoned in some manner different from future or past, but still in a way having definite algebraical connexion with time which is gone, and time which is to come. It is clear that in actual experience there is no process to which such measurements correspond. Time has no meaning except as future or past; and the present is but the meeting point of the two. Or, once more, suppose that we are gravely told that all circles pass through the same two imaginary points at an infinite distance, and that every line drawn through one of these points is perpendicular to itself. On hearing the statement, we shall probably whisper, with a smile or a sigh, that we hope it is not true; but that in any case it is a long way off, and perhaps, after all, it does not very much signify. If, however, as mathematicians we are not satisfied to dismiss the question on these terms, we ourselves must admit that we have here reached a definite point of issue. Our science must either give a rational account of the dilemma, or yield the position as no longer tenable.

Special modes of explaining this anomalous state of things have occurred to mathematicians. But, omitting details as unsuited to the present occasion, it will, I think, be sufficient to point out in general terms that a solution of the difficulty is to be found in the fact that the formulæ which give rise to these results are more comprehensive than the signification assigned to them; and when we pass out of the condition of things first contemplated they cannot (as it is obvious they ought not) give us any results intelligible on that basis. But it does not therefore by any means follow that upon a more enlarged basis the formulæ are incapable of interpretation; on the contrary, the difficulty at which we have arrived indicates that there must be some more comprehensive statement of the problem which will include cases impossible in the more limited, but possible in the wider view of the subject.

A very simple instance will illustrate the matter. If from a point outside a circle we draw a straight line to touch the curve, the distance between the starting point of contact has certain geometrical properties. If the starting point be shifted nearer and nearer to the circle the distance in question becomes shorter, and ultimately vanishes. But as soon as the point passes to the interior of the circle the notion of a tangent and distance to the point of contact cease to have any meaning; and the same anomalous condition of things prevails as long as the point remains in the interior. But if the point be shifted still further until it emerges on the other side, the tangent and its properties resume their reality, and are as intelligible as before.

(To be continued.)

THE INVENTION OF THE MICROPHONE

SINCE the name of Sir William Thomson has been imported into the controversy as to the authorship of the microphone, we re-publish the following letter which that gentlemen has addressed to our contemporary, *Nature*.

"THE MICROPHONE.

"The pleasure with which those beautiful discoveries and inventions, the telephone, the phonograph, and the microphone, have been appreciated by the world, has been unhappily, and I must say I think unnecessarily, marred by one of the most disagreeable things that can be thrust on the public—a personal claim of priority, accompanied by accusations of bad faith, especially when made against any one of whose name and fame the public has come to feel concerned.

"Before troubling the public at all with such a matter, Mr. Edison might surely have reasoned out his claim with Mr. Preece, with whom he had been from the beginning in correspondence, or he might have written immediately to public journals, calmly pointing out the close relation between his own 'carbon telephone' and Mr. Hughes' subsequent 'microphone.' The scientific public could then have calmly judged, and would have felt much interest in judging, how much in common, or how much not in common, there may be in the physical principles concerned in the two instruments. But by his violent attack in public journals on Mr. Preece and Mr. Hughes, charging them with 'piracy' and 'plagiarism,' and 'abuse of confidence,' he has rendered it for the time impossible for either them or others to give any consideration whatever to his claims. Nothing can be more unfounded than the accusations! Mr. Preece himself gave, at the Plymouth meeting of the British Association last August, a clear and thoroughly appreciative description of Edison's carbon telephone, and published it in the printed reports of his lecture, which appeared in the public journals. The beautiful results shown since the beginning of the present year by Mr. Hughes with his microphone were described by himself in such a manner as to leave no doubt but that he had worked them out quite independently, and that he had not the slightest intention of appropriating any credit due to Mr. Edison. It does seem to me that the physical principle used by Edison in his carbon telephone and by Hughes in the microphone is one and the same, and that it is the same as that used by M. Clérac, of the French 'Administration des Lignes Télégraphiques,' in the 'variable resistance carbon tubes,' which he had given to Mr. Hughes and others for important practical applications as early as 1866, and that it depends entirely on the fact long ago pointed out by Du Moncel, that increase of pressure between two conductors in contact produces diminution of electric resistance between them.

"I cannot but think that Mr. Edison will see that he has let himself be hurried into an injustice, and that he will therefore not rest until he retracts his accusations of bad faith publicly and amply as he made them.

"WILLIAM THOMSON.

"Yacht 'Lalla Rookh,' Cowes, July 30."

From an article entitled, "Une Querelle a propos du Microphone," by M. A. de Montlambert, which appears in *L'electricité* for July 20, we translate the following instructive passages:—"Before passing to the microphonic arrangement, which is the bone of contention, we would draw the reader's attention to the two following points which, as will be at once seen, ought to be taken into serious consideration. First, the property which certain conductors, and particularly powdered carbon, possess of varying their conductivity with pressure, was known a long time ago. M. Clérac, of the French Telegraph Administration, had applied it in 1866 in constructing a cheap rheostat, formed of a tube filled with plumbago or powdered carbon, in which a piston was moved by a screw. By working the screw, the resistance of the circuit in which the tube was intercalated was considerably increased or diminished. Moreover, M. du Moncel, making, in 1856, some researches on the resistance presented by the contacts of electric keys, or contact breakers, had proved *that the intensity of currents transmitted by their means varied with the degree of pressure exerted between the two pieces in contact.* (See Vol. 1., p. 246 of 2nd ed. of M. du Moncel's *Traité des applications de l'electricité*, 1856). Further, he recognised this property in 1872-1876, when making experiments upon the conductivity of divided conductors, and announced it in several memoirs presented to the Academy of Sciences since that time. Lastly, M. Pollard, in constructing a telephone, with a pencil of plumbago, simply leaning against the diaphragm, has shown, in December, 1877, that the variation of conductivity with pressure held equally well for hard carbonised bodies as for those soft charcoals exclusively employed by Mr. Edison. . . . . . .

"The claim of Mr. Edison relative to the property possessed by the microphone of serving as a thermoscope proves that he has not at all understood the question. In the first place, Mr. Hughes has never pretended to the invention of a *thermopile*, as Mr. Edison states, but merely to a *thermoscope*, and that thermoscope *is based upon a principle diametrically opposite to that on which the micro-tasimeter of Mr. Edison is founded.* In the latter the effects of heat are indicated by increase of pressure on a disc of carbon, produced by the dilation of a body sensitive to the heat rays which fall upon it. In the apparatus of Mr. Hughes, there are several pieces of carbon enclosed in a quill, and touching each other so lightly as to cause a somewhat unsteady deflection on a sensitive galvanometer, when a current is sent through them. Now, a minute increment of heat has the effect of increasing in a high ratio the resistance of the contacts, and the deflection diminishes in proportion as the heat is increased. This phenomenon has been studied since 1875 by M. du Moncel, who has proved that in middling conductors, of the nature of carbon, pyrolusite (peroxide of manganese), plumbago, and even metal filings, the first effect of heat is to diminish the conductivity of them, but that if they are heated above 100° C., the reverse effect takes place, and the conductivity becomes greater, a fact which he attributed to the dilatation of the particles of the body, which produced an effect analogous to that which would result from an increase of pressure. (See M. du Moncel's Memoir in *Comptes Rendus*,

Nov. 2, 1875). Mr. Edison is therefore mistaken, and this claim of his has no foundation whatever."

The passage from the *Traité des applications de l'electricité* above alluded to, runs thus :—"A very curious fact, and one which appears to be at first sight, in contradiction to the received theory of electricity, is that *the greater* or less pressure between the contact pieces of interrupters, influences considerably the intensity of the current which traverses them. This often results from the studs of the key not being clean, *but it may also be due to a physical cause as yet poorly appreciated.* One thing certain is that with keys, in which the moveable contact piece is urged by an extremely feeble force, the current is often so weak that it fails to effect the electric reaction expected from it."

Apropos of this interesting extract, we (the TELEGRAPHIC JOURNAL) may point out that it is within the experience of all practical electricians and operators that a firm, definite contact is requisite in testing or signalling, to give a steady and good result on a sensitive galvanometer or receiver. A slow and gentle contact is found to influence the current. Soon after hearing of the discovery of the microphone, it occurred to us that the two contacts of an ordinary signalling key might form a more or less sensitive microphone at a certain intensity of the pressure exerted upon them by the hand of the signalling clerk. The researches of M. Du Moncel corroborate this view. If it be correct, the key when in a microphonic state, would transmit microphonically part of the jar or vibration produced by the shock of closing its contacts. We may, therefore, reasonably look for a perturbation in the rise of a current flowing through a key in the act of being closed; and this perturbation will necessarily vary with the mode in which the contacts are produced; a feeble and slow contact causing a different disturbance to that from a smart decided contact. The truth of this supposition might be tested by employing a telephone as the interpreter of the current, as the perturbations will be very delicate. The question is not without its practical importance, since if it be true, the superiority of mechanically effected contacts over hand contacts, in electrical experiments at least, will be apparent; and it is not unlikely that some of those experiments hitherto made on the flow of an electric current into a wire or cable may have to be verified again or corrected.

In an interesting communication to the French Academy of Sciences, M. Du Moncel himself has described the results of his early and later researches on the variation of resistance of contacts and imperfectly conducting bodies under pressure. From this it appears, in addition to the above facts quoted from M. Montalambert, that M. Du Moncel also described in the 1856 edition of his *Exposé*, two kinds of carbon contact breakers for producing undulatory currents. He was led to construct these by the discovery which he made in experimenting with brass, iron, platinum, and carbon conductors, that *the differences of intensity* of the current increased proportionately as the bodies employed increased in desistance. This fact he afterwards (in 1872) remonstrated, when he showed the variations in resistance which wood, charcoal, and coke in a fine state of division could undergo. He then noticed that these subdivided conductors had a *less* or *greater resistance*, according to the more or less bright condition of the metallic particles, and the greater or less degree to which they were concentrated round the electrodes inserted into them.

Touching M. Clérac's researches in 1865, M. Du Moncel also cites the report of M. Zetzsche on the Vienna Exhibition of 1873, published in the *Journal Telegraphique*, for Feburary 25th, 1874:—"As regards rheostats, the historical part of the exhibition contains, besides the ordinary kinds, graphite rheostats employed since 1865, on intermediate stations to regulate the resistance of the line, &c."

THE MICROPHONE RELAY.

By Profs. EDWIN J. HOUSTON and ELIHU THOMSON, of the Philadelphia Central High School.

IMMEDIATELY after the announcement by Prof. Bell of his remarkable invention of the articulating telephone, we proposed for ourselves the task of relaying this instrument. Quite a number of different arrangements were tried, but, owing to the exceedingly feeble movements of the diaphragm of the receiving telephone, none of them were very successful. The discovery by Prof. Hughes, however, of the inexpressibly delicate microphone, happily afforded us the means of at last solving the problem at which we had been so long engaged.

In our application of the microphone for the relaying of the telephone, we attach a miniature microphone to the plate of the receiving telephone. The microphone so attached consists essentially of three small pieces of carbon, each being about $\frac{3}{8}$ of of an inch in length. These pieces are arranged exactly as in the manner described by Prof. Hughes, viz., one of the pieces of carbon, which is sharpened at both ends, rests vertically in small cavities near the ends of the two other pieces, as shown in fig. 1. The two carbon supports for the third piece are cemented at their ends directly to the plate of the telephone.

The microphone so constructed is placed in the new circuit in which it is desired to repeat the message originally transmitted. The method of its operation is evident. The slight movements of the diaphragm of the receiving telephone, which are, in fact, so slight as to render them almost impossible of detection by mechanical means, are nevertheless at once recognized by the marvellously sensitive microphone, and are repeated in the new circuit as variations in the intensity of the electrical current traversing it. The message so relayed or repeated, for it is evident that the instrument can be used either as a relayer or a repeater, may be either received at once by a telephone placed in said circuit, or may be again repeated in a new circuit. By this means we believe that the distance to which a telephone message can be transmitted will be very greatly increased.

Owing to the extreme sensitiveness of the microphone, it will be necessary, in the practical application of this instrument as a relay, to carefully shield it from all extraneous sounds, which, weak though

they may be, are, nevertheless, very loud when compared with those which would be produced by the feeble movements of the plate of the receiving telephone. This may be obtained in practice in several ways, as, for example, by placing the microphone relay in a box with double or treble hollow walls lined with cotton, wool, or some other non-homogeneous material, or by sinking the instrument in a pit under ground. We have found but little difficulty, however, in the trial of our instrument over a city line of some three miles in length, of obtaining the quiet necessary for the working of the instrument, although the latter was placed in a large room in the second story of a building facing a public thorougfare, and the time of trial was shortly after midday.

slightly inclined. In this position more force is required to move the upright piece, and so cause it to vary the electrical resistance. In all the microphones that we have experimented with when the upright piece was held nearly vertically, whispers or other faint sounds were distinctly transmitted, but the voice of a person standing a few feet from the instrument, and speaking as in ordinary conversation, caused such a rattling of the receiving instrument as either to render the sound unintelligible or greatly confused. In all such cases, a certain inclination could be obtained, varying slightly in each instrument, at which the rattling of the instrument entirely disappeared, and the sound was distinctly and loudly transmitted.

When the microphone relay is placed in a circuit

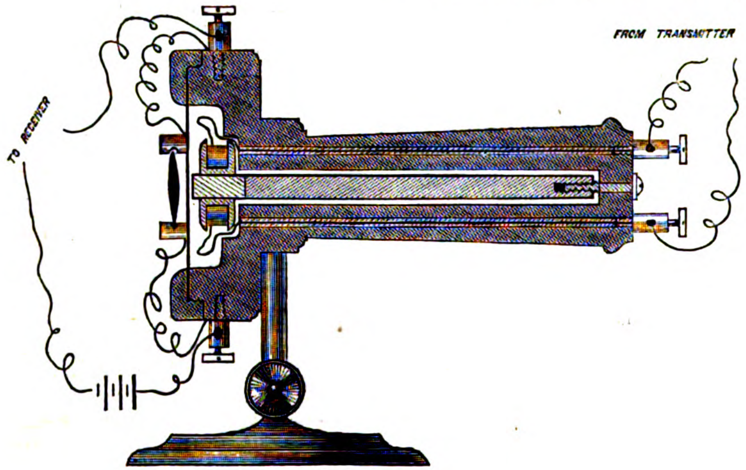


Fig. 1.

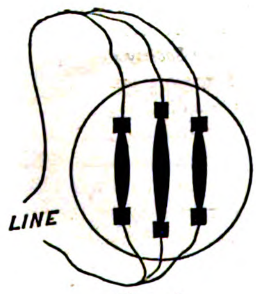


Fig. 2.

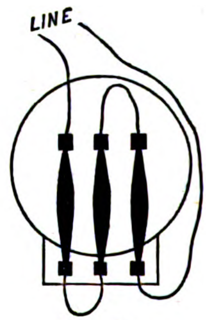


Fig. 3.

The microphone, when properly constructed, has its greatest sensitiveness when the piece of carbon pointed at both ends rests in a nearly vertical position. Its electrical resistance is then at its maximum. In this position the upright carbon is resting on its extreme ends, and the cross-section of contact a minimum. So placed the slightest acoustic movement brings portions of the conical surfaces of the upright piece against the edges of the cavities, and thereby diminishes the resistance by increasing the area of the surfaces in contact. If now it be desired to diminish the sensitiveness of the instrument, it is only necessary that it be so placed that the upright carbon be no longer supported vertically, but be

whose resistance is considerable, as, for example, at the end of a distant station, we increase the sensitiveness of the instrument by attaching a number of minute microphones to the receiving diaphragm, as shown in the figures. These may be connected in series, as in fig. 3, or in multiple arc, as in fig. 2.

Since the variation in the electrical resistance of the microphone depends mainly on the upper contact of the loose piece with its support, an increased delicacy may be obtained by attaching this support directly to the middle of the diaphragm of the receiving instrument, while the lower support need not necessarily be attached to the diaphragm.

We have measured the resistance of a microphone, in which the moveable piece was composed of a piece of carbon about $1\frac{1}{4}$ inches long and $\frac{1}{4}$ inch square, and find that when placed in an upright position it has a resistance of about 50 ohms, varying, however, in a marked manner, with any sound. The same instrument, when turned at an angle of about 40° from the vertical, was found to have its resistance diminished to about 25 ohms.

It may be mentioned, as an interesting fact in regard to the microphone, that when the upright piece is placed in the position of its greatest sensitiveness, and a moderately loud sound is made near it, although such sound is only transmitted as a confused rattling, yet its resonance can, in most cases, be distinctly heard. This is probably the cause of the peculiar ringing sound heard when the microphone transmits mere noises, such as those produced by a person walking.

Review.

The Speaking Telephone, Talking Phonograph, and other Novelties. By GEORGE B. PRESCOTT. Fully Illustrated. New York: D. Appleton and Company.

THE object which the author has had in view in preparing this work, as stated in the preface, has been to furnish the public with a clear and accurate description of the more recent and useful improvements in electrical science, and more particularly of the speaking telephone. Mr. Prescott has shown himself thoroughly competent to attain this object, and has produced a work which is a most useful addition to the list of records of the triumphs of electrical science, especially of those won in America. The amount of knowledge of electro-telephony which has been gained may be gathered from the fact that 300 pages in Mr. Prescott's work scarce suffice to deal with the subject. Every pains have evidently been taken to make the information given as complete as possible.

The latter portion of the work deals very fully with quadruplex telegraphy, showing every conceivable modification of the principles involved for working forked circuits, and for "repeating," &c. The ingenious compound-relay of Mr. Geritt Smith, to which the success of quadruplex telegraphy and its modifications is mainly due, is conspicuous in all these arrangements. The chapter devoted to this subject terminates with a description of the ingenious electro-motograph of Mr. Edison.

A chapter on Call Bells, and another on the Electric Light, in which a considerable amount of useful information is given, concludes the work, which we can heartily recommend to our readers.

Notes.

THE TELEPHONE.—Under the American patents, some 14,000 telephones have, during the past year been installed in the United States, and are being rented at an average rental of £10 per ann.; and fresh orders are being received at the rate of 1,000 sets per month.

WE are glad to observe that a notable reduction in the price and rental of telephones in England has been made by the recently organised Bell Telephone Company, Cannon Street. The former suicidal rates charged for the use of telephones in this country was a matter of regret to all acquainted with the subject. "Make hay while the sun shines" should be the motto of successful inventors; and, as even the telephone may be improved upon or superseded, it was felt that Prof. Bell was losing the harvest which his genius and labour had earned for him. Single telephones for experimental and lecture purposes are now sold at £2 a piece; a pair of domestic telephones with battery, call bell, switch, and 50 yards of wire at £5 10s.; a pair of business telephones with auxiliary apparatus and 100 yards of wire at £7 10s.; mining telephones at £15. Higher styles of telephone than these are charged for at various rates up to £20. There ought to be a wide field for the local use of the telephone in this country, and we are certain that nothing but the high prices hitherto charged for them has stood in the way of their rapid spread.

TELEPHONE CALLS.—In M. Alfred Niaudet's call, the ordinary telephone is transformed into a Reis' make-and-break telephone, by pressing a button in the telephone, and the voice is used to interrupt the circuit. In Mr. E. Conrad Cooke's, a wheel, with a milled rim is turned by hand, and a spring contact rasping on the rim causes an intermittent current to flow through the telephone. Mr. Edison also constructs a call by arranging a pivoted lever with one end resting lightly on the diaphragm of the telephone, so that when an intermittent battery current comes from the other station, the lever will dance up and down on the diaphragm and make a drumming sound. The latest call is that of Mr. A. Le Neve Foster described in the *Journal of the Society of Arts*, August 2nd. It consists of an electro-magnet with a vibrating armature or reed, which makes contact with two opposite contacts alternately like the tongue of a relay; and a local battery and key or press-button. The battery is connected up to the armature on one hand and to one of the sole contacts of the key on the other; the electro-magnet is connected up between the upper armature contact and the line; the lower armature contact is to earth, the lever of the key is to line, and the other sole contact of the key is to the telephone. When the key is at rest the line is to earth through the telephone, and speaking can be carried on by telephone; but by depressing the key, the telephone is disconnected from the line and the call substituted for it. The current from the local battery traverses the electro-magnet by way of the upper contact and the armature, and traverses the line to the distant telephone. The armature vibrates under the attraction of the electro-magnet and interrupts the circuit so as to make the line-current intermittent.

THE Sainte-Etienne Colliery Company of France

have six telephone lines working, the longest extending nearly four miles. Conversation is carried on at the rate of about 100 words per minute. The telephones were made by Brèguet, and cost 12s. 6d. each.

ACCORDING to Chin Hoo, in the Pekin *Gazette*, the telephone, or, "Thumthsein," was invented in China in the year 968 by a philosopher named Kung Foo Whing. This announcement will satisfy the self-complacency of the Celestials without disturbing the equanimity of the western nations. All honour to Kung Foo Whing, whose euphonious name seems made for the telephone.

M. DU MONCEL recently drew the attention of the French Academy of Sciences to the fact, that if any part of the telephone circuit wire be scratched, a feeble grating sound will be heard in the telephones. This sound becomes very marked when those parts of the wire, close to a telephone itself, were scratched. The effect was not merely mechanical, for it ceased when the current was interrupted. This peculiar fact throws light on the clamour of confused sounds heard in telephones connected in circuit with ordinary telegraph lines, some of which sounds were evidently not due to induction from the neighbouring lines.

THE MICROPHONE.—*Naturforscher*, the German *Nature*, mentions another inventor of the microphone—a M. Lüdgte—who described a microphone made of two metal plates in contact, a battery and bell telephone, to the Berlin Physical Society in April last. Professor Hughes has evidently won the honours of the discovery "by a neck."

M. DUCRETET has applied the pneumatic tube vibration-transmitter employed by M. Marey in physiological experiments to the microphone. This consists of a flexible india rubber pipe connecting two small drums, or closed air chambers with convex lens-shaped membranes, so that when one of the membranes is pressed against the pulse, the other membrane will pulsate the air transmitted air-vibrations. M. Ducretet makes use of it by resting one of the lens-shaped membranes upon the upper contact of a pencil microphone, leaving the other drum free to be applied to the pulse, the lungs, heart, or other organ of the body. This has been called the *stethoscopic* microphone.

PROFESSOR HUGHES is of opinion that the microphone shows the electric current to be a molecular vibration, which becomes manifest when the molecules of the conductor are free to move by reason of the feeble contact produced under the influence of a very light pressure between two or several parts of the conducting circuit.

MR. EDISON, has we believe, publicly claimed the microphonic repeater, or relay of Professors Houston and Thomson, which we illustrate in this number. He declares it to have been devised by him over a year ago, and published in the *Journal of the Telegraph*, July 15, 1877, and the TELEGRAPHIC JOURNAL about the same time. Mr. Edison doubtless refers to his Pressure Relay. See TELEGRAPHIC JOURNAL, p. 149, Vol. 5, July 1st, 1877.

COUNT DU MONCEL makes a microphone for transmitting speech, of a box lined at one end with zinc and at the other with copper, and containing a layer of fragments of gas carbon steeped in water.

THE microphone is another marvellous invention. By it the faintest sounds are magnified to the dimensions of a thunder-clap. With the microphone a farmer can hear a potato-bug coming down the road a quarter of a mile away, and can go out with an axe and head it off.—*Danbury News*, U.S.

PROFESSOR W. F. BARRETT has pointed out that the term microphone was first used by Sir Charles Wheatstone to designate a mechanical contrivance of his for magnifying small sounds. It is fully described in the *Quarterly Journal of Science*, Part II., 1827.

THE PHONOGRAPH.—In the "Connexion of the Physical Sciences," Mrs. Mary Somerville wrote some forty years ago: "It may be presumed that ultimately the utterence or pronunciation of modern languages will be conveyed not only to the eye, but also to the ear of posterity. Had the ancients possessed the means of transmitting such definite sounds, the civilized world might have responded in sympathetic notes at the distance of many ages." Sir Charles Wheatstone and Sir David Brewster also joined in the expectation, "that before this century is completed, a talking and singing machine will be numbered among the conquests of science."

IN that singular romance, *Contarini Fleming*, Lord Beaconsfield argues at some length that the days of metrical poetry are numbered; that it was a product of the ancient times before the printing press, when poems were sung or recited, not read, and that it would vanish before long after the bards which gave to it birth. Mr. Carlyle and many other eminent writers hold a similar faith. But the phonograph has falsified this doctrine, and the beauty and music of words will still be worth preserving.

THE phonograph has recently created some sensation in new York by repeating before a large audience one of the famous solos of Levy, the cornet-à-piston player. All Levy's most brilliant execution was faithfully reproduced.

PROFESSORS FLEEMING JENKIN and J. E. EWING continue their experiments on vowel sounds by means

of the phonograph. They obtain current curves representing the path of an air particle in sound waves from the phonograph record, by a multiplying lever arrangement and marker similar to that used in Sir William Thomson's Syphon Recorder. Curves of "visible speech" 400 times the size of those imprinted on the phonograph foil are thus obtained. Touching this subject, the *American Journal* for July, gives a full account of an ingenious method of Professor E. W. Blake Brown, University, U.S., for recording articulate vibrations by means of photography.

MR. EDISON has been investigating the constancy of the phonograph marking with a view to reading the record by sight; but although a fundamental form for each syllable or articulated sound doubtless exists, it is difficult to get it freed from what may be called accidental influences. For example, the same sound uttered by different persons gives a different form of indentation, as also does the manner in which it is spoken, or the distance from the diaphragm at which the speaker's mouth is placed, or the force with which it is uttered, or the speed at which the barrel is turned. If the hand be pressed on the cheek while speaking, a different character will be given to the rut in the foil. Vowels are little liable to these variations as compared with consonants.

THE researches now being made by help of the phonograph and phonautograph, into the vibrations of speech, and the visible form of sound waves, should result in a typical or general form, and Mr. J. Munro suggests that phonographic type should be cast of all the phonographic syllables used in speech, so that a phonograph matrix might be composed as a printer's page is now composed. With these phonographic characters there would be no need to speak into a phonograph, and multiply the record by electro-typing (unless individual peculiarities of speech were to be preserved), since the type could be set up mechanically. In this way very powerful phonographs, giving loud articulations of what may be called ideal speech, would be practicable.

THE ELECTRIC LIGHT.—We publish in this number an account of Rapieff's electric lamp.

IT is said that the thirty-four Jablochkoff's electric candles in the Avenue de l'Opera, Paris, are costing £20 per night. The light, however, is more than sufficient for the purpose. Over 300 candles are lit nightly in Paris.

THE different kinds of electric light are now fairly installed at the Paris Exhibition. As many as eighteen different lamps are on view, exclusive of Jablochkoff's candle.

ACCORDING to *L'electricité*, the Paris Gas Company has published in several financial journals an article on the alarm caused by the progress of the electric light, intended to reassure the shareholders of gas companies. The article contests the possibility of substituting the electric light for gas in cities, and concludes that the gas companies run no danger. Energetic efforts are also being made to develope the use of gas for cooking and heating. Meanwhile the splendid lights of Lontin, Siemens, and Jablochkoff steadily burn on, shaming the rows of sickly and feeble gas lights wherever they are seen beside the latter. Even so will truth outshine error, although error be supported by millions. A visit to the Avenue de l'Opera, Paris, just now, is the best possible argument against the inspired article of the Parisian Gas Company.

THE learned Abbé Moigno, director of *Les Mondes*, has suggested to M. Giffard, the English æronaut, the desirability of making several nocturnal ascents in his giant captive balloon at the Paris Exhibition, in order to determine the laws of visibility at a distance by means of an electric lamp placed under the car.

We learn from the *Polytechnic Review*, U.S., that the Telegraphic Supply Company of Cleveland is so crowded with orders for Brush electric light apparatus, for the illumination of mills, depôts, factories, &c., &c., that it has been compelled to run day and night, and is now arranging for a factory four times the capacity of its present one.

AN experimental trial of Lontin's electric light was recently made at the Gaiety Theatre. From the results obtained, there would seem to be good reasons for believing that the expectations of those who have introduced the novelty to the metropolis will be fully realised at no distant date. In order to show that one of the great difficulties in the way of the application of electric lighting—the division of the light—has been surmounted, and that, in fact, the lighting power can be produced at least half a mile from the machinery which forms its source and supply, it is in contemplation to carry the connecting wires from the Gaiety Theatre to Pall Mall.

IT is reported that the Metropolitan Board of Works are seriously meditating the illumination of the Thames Embankment by the electric light. They could not have chosen a better starting ground.

THE joint committee of Her Majesty's Commissioners and of the Society of Arts for promoting visits of selected artizan reporters to the Paris Exhibition have now settled the conditions under which artizans will be sent to Paris. Each artizan is expected to devote from eight to fourteen days to his visit, and pay all his expenses out of a bonus of £8, which will be presented to him. Free admission to the Exhibition will be granted; return tickets, London, Chatham and Dover Railway, for fourteen days, can be obtained at the price of 20s.

Arrangements for getting food and lodging in Paris have also been provided. Besides the artizans selected by the joint committee, artizans may be sent at the expense of their employers or local committees.

A special committee of the Society of Telegraph Engineers, including Mr. Latimer Clark, C.E., Mr. Hall, and Mr. C. V. Walker, F.R.S., among its members, has been appointed to devise a standard wire gauge.

Among the novelties to be seen at the Paris Exhibition is a series of specimens of electro-plated human brains, sent by Dr. Ore, the ingenious Professor of Physiology at the Bordeaux School of Medicine. Dr. Ore has applied galvano-plasty for purposes of preservation to the brains of men and animals, and has obtained very remarkable results, the external surface presenting the hard brilliant surface of a metal, while the inner substance assumes the consistency of mastic, and is quite unalterable.—*Scientific American.*

Gray's harmonic telegraph can now be seen in operation at the Paris Exhibition. It is connected up with the Morse instrument so that the vibratory telephone messages are sent simultaneously with the Morse messages in a manner indicated by Varley in his 1870 patent.

We hear that a son of Mr. John Pender, M.P., is at Cyprus arranging for the laying of a cable to connect that island with the Eastern Telegraph Company's Mediterranean system.

Two companies of Royal Engineers from the Southern Division of the Postal Telegraphs, have left in H.M.S. *Simoom* for Cyprus, to erect military telegraph lines there.

The s.s. *Minia*, of the Anglo-American Cable, has been engaged in removing the Duxbury Cable into water freer from mishaps by fishing boats than its old position.

During the last two years the "errors" in messages committed by the Eastern Telegraph Company were only 1,615 words. During three months 561 repetitions were made, which comprised 11,684 words in all, and represented a money value of £3,840.

As mentioned in the "City Notes" of our last issue, the steamers *Seine* and *Calabria* sent out by the Anglo-American Telegraph Company to repair the 1866 Atlantic Cable, have returned without success. The cable was hooked several times, but the iron sheathing was so rusted that it could not bear the stress of raising the cable to the surface.

A Quick Telegram.—The Agent-General for South Australia sent a telegram to Adelaide, South Australia, at 3.0 p.m. on Monday, the 22nd ult., from Broad Street, E.C., and received a reply to it at Westminster 18¾ hours after.

In Parliament, on August 8th, Mr. Anderson asked the Postmaster-General to consider the expediency of adopting a letter or syllable tariff instead of a word tariff, for postal telegrams. The Postmaster-General also announced that an International Telegraphic Congress would be held in London, next June. Mr. Whitwell proposed that the inequality of the rates between telegrams from the Continent to London and telegrams from the Continent to the provinces be removed. Lord John Manners replied that negotiations to that end were now pending between two or three foreign governments.

An official superior school of telegraphy will commence in Paris, on November 4th. A preliminary examination for the admission of pupils will be held in several of the cities of France, and the final examination will take place on October 21st in Paris. Besides the students of telegraphy in the Ecole Polytechnique, it will be open to postmasters and operators reckoning two years service, to licentiates in science, old pupils of the Ecole Polytechnique, and of the Ecole Normale, Ecole des Mines, Ecole des ponts et Chaussées, Ecoles Forestière, Ecole Centrale des Arts et Manufactures, and there will be a certain number of free students, French or foreign, authorised to attend. A preliminary course, of a year's duration, will be instituted to prepare postmasters and operators for their entrance examination. Passes for admission to the examination should be addressed to the Sous-secretaire d'Etat des Finances before September 1st. Further information can be procured by application to the Central Telegraph Station, Paris, 103, Rue de Grenelle, St. Germain.

A new volume entitled *Recueil de Memoires relatifs à la physique des muscles et des nerfs*, has recently been published in Germany by Du bois Raymond. It contains his researches on various subjects, electrical and other, since 1855. To these are added a memoir for the first time published of his observations on the electric phenomena of the *Malapterure* a creature never before investigated in a laboratory.

Cobalt Plating. — An interesting and valuable communication on this subject has recently been made to the French Academy of Sciences. It appears that M. Gaiffe, while studying some of the properties of magnetic metals, obtained by means of the voltaic current, was struck with the superior beauty and hardness of cobalt over iron or nickel, and thought that it might be advantageously utilized in electro-plating if it could be treated as easily as such metals as iron or nickel. Some beautiful samples of the plating on strips and bas-reliefs of red copper were shown to the Academy. The colour is a bright white, resembling old silver. It

is principally for fine-line engraving, such as etching, and for typography that cobalt plating will be useful. It does not oxidize like iron, and it is more durable than either iron or nickel. It is also more easily dissolved in acids, so weak as not to attack copper, whilst nickel can only be readily dissolved in acids which corode copper, so that cobalt may be removed from copper with more facility than nickel. A new plating may thus be substituted for a worn one without injuring the copper basis underneath. The bath employed by M. Gaiffe is a neutral solution of double sulphate of cobalt and ammonia, the mode being a platinum foil, or better a plate of cast or forged cobalt. Cobalt herein differs from iron and nickel, which are not soluble in their baths when pure. To obtain a very regular deposit the article to be plated should be fixed to the electrode of the battery before being immersed in the bath, as without this precaution a marbling is produced on the surface. The deposit is effected almost as rapidly as nickel. M. Edmund Becquerel at a subsequent meeting of the French Academy, pointed out that he and his father had, generally speaking, anticipated the results of M. Gaiffe in a memoir to the Academy in 1862. In this memoir it was also laid down that in order to obtain a coherent deposit, the intensity of the current should be in proportion to the density of the solution to be decomposed. M. Gaiffe recommends an electro-motive force of six volts at the beginning of the operation, diminishing to about three volts towards the end.

New Patents.

2816. "Improvements in magnetising metal or other substances, and utilising same for producing magnetic, telephonic, microphonic, and acoustic effects."—G. E. PRITCHETT. Dated July 13.

2852. "An improved method of communication by means of electrical currents between the passengers and officials in railway trains, and apparatus therefor."—R. W. HAMMOND (communicated by V. von Scheliba). Dated July 17.

2878. "A new or improved electric motor, parts of which are applicable to other electro-magnetic appliances."—E. J. HARLING and R. BULL. Dated July 18.

2929. "Pneumatic domestic signalling apparatus."—J. T. Gent. Dated July 23.

3011. "Improvements in rheophores in commutators and in galvanic batteries connected therewith, particularly applicable to medical purposes."—J. and J. ARNOLD, and J. J. H. Sandy. Dated July 29.

3033. "Improvements in railway switches or points and in the mode of connecting the same with the signals."—E. FELDTMANN (communicated by A. Blanel). Dated July 31.

3040. "Improvements in mechanism or apparatus to be applied to doors, windows, shutters, drawers, and other articles for the purpose of giving an alarm when burglarious or improper attempts are made to open the same."—R. E. N. MASON and J. PRICE. Dated July 31.

3080. "Electric telegraphs."—J. W. BROWN. Dated August 3.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

4555. "Lighting gas lamps or burners by electricity, &c."—ALEXIS Voisin. Dated December 1, 1877. 2d. A platinum wire, heated by an electric current from a battery, is made to ignite the gas. The turning of the gas cock lets on both gas and current. (*Not proceeded with.*)

4608. "Apparatus for repeating voice sounds by electricity."—CAPT. M. T. SALE, R. E. Dated December 5, 1877. 4d. This describes a telephone, consisting of a vibrating membrane fitted with a platinum contact stud at its centre. This stud is opposite an adjustable screw contact; a battery is connected in circuit with the diaphragm contact, the screw contact, and the line. A drop of conducting liquid or a flame completes the circuit between the contacts. The vibrations of the voice impart their motion to the diaphragm, which varies the resistance of the fluid contact, and sends wave currents into the line. (*Not proceeded with.*)

4685. "Telephones."—CARL HEINRICH SIEMENS (communicated by Dr. E. Werner Siemens, Berlin). Dated December 10, 1877. This consists in overcoming the straining of the diaphragm of a telephone out of its natural position under the attraction of the one electro-magnet adjacent to it, by placing the diaphragm between two electro-magnets. For this purpose, according to one construction, the iron diaphragm is fixed in a circular box, each side of which is a permanently magnetic disc. At the centre of one of these discs there is a core, surrounded by a coil. The other disc on the opposite side of the diaphragm has a hole in its centre for the passage of the sound waves. This disc being opposite to the other disc and core, the iron diaphragm rests between the two in equilibrium, without being strained more in one direction than in the other. Instead of an iron diaphragm, a non-metallic one may be employed, having a light annular coil of aluminium on its face, vibrating with it in a magnetic field formed of the annular space between a magnetic core and a surrounding tubular magnetic disc. Bells or tuning-forks may be employed in lieu of diaphragms so as to transmit bell or other tones.

4706. "Voltaic medicated plaster."—WARREN BAILEY POTTER, Boston, Mass., U. S. Dated December 11, 1877. 6d. This consists in forming these plasters so that the plaster shall lie between the skin and the strips of zinc and copper forming the voltaic arrangement. Holes are punched through the plaster exposing portions of the plates, which are connected in series by strips of cloth.

4748. "Magneto-electric Machines."—E. WESTON, New York, U.S. Dated December 14, 1877. 6d. This consists in improvements in Weston's machine, described in a prior patent, No. 4280, of 1876. These are the combination with a commutator of two brushes attached to a pivoted disc, whose axis coincides with the axis of the commutator shaft, the disc being provided with one or more set screws, whereby it may be clamped in variable positions, for the purpose of regulating the strength of the current. Also a device for automatically closing and breaking the circuit, by means of a disc attached to a shaft, which has its bearing in the end of a pillar, and is rotated by means of a belt from the shaft of the machine. The disc contains two radial slots, each of which contains a sliding switch block, which is pressed inward toward the axis of the disc by an adjustable spiral spring. These blocks rest against a metal hub, when they yield to the action of the springs. When the speed of the machine falls below a certain rate, the switch blocks form an electrical contact with the hub, and the current from the machine is short circuited. On the contrary, when the desired rate of speed is attained, the current is sent through the line into the electro-typing vats, &c.

4803. "Metallic cement for galvanic batteries." M. F. ROBERTS. Dated December 17, 1877. 2d. This con-

sists in forming the zinc pole of cells of a solid alloy of zinc and mercury, in preference to amalgamating it. The alloy is formed by running together say, 7 parts of molten zinc and 1 part of an alloy of equal quantities of zinc and mercury. (*Not proceeded with.*)

4824. "Insulating telegraph wires, &c." BRISTOW HUNT (communicated by D. Brooks, Philadelphia, U.S.) Dated December 19, 1877. 6d. This consists in covering wires with cotton, heating it to 300° to 320° Fah. for 1½ hours, to expel the moisture and gases from the fibres, and then plunging it into melted paraffine or paraffine oil. Wires and cables so prepared are introduced into iron pipes while both pipe and cable are at the above temperatures. These pipes are in convenient lengths for laying from barges or waggons.

4847. "Telephonic apparatus." CHARLES AMBROSE McEVOY. Dated December 20, 1877. 6d. This consists in making one telephone serve for sending and receiving at each end of a line. A pipe leading out from the chamber in rear of the metal diaphragm, which chamber is made deeper than usual, is provided at its extremity with a small trumpet mouth, into which the message to be sent is spoken. This pipe is provided with elbow bends, so that when the diaphragm is held in the ordinary way close to the ear of the listener, the mouthpiece may be just in front of his mouth; or the tube may be long and flexible.

Correspondence.

LIEUT. H. P. KNIGHT.—The manufacturers of De la Rue's cell as described are Messrs. Latimer Clark, Muirhead & Company, 29, Regency Street, Westminster. The price is, we believe, about 2s. per cell. We have personally seen this cell at work for months, and can testify to its merits. To our knowledge a set of twenty were used daily in cable-testing for six months without having shown any unsteadiness or loss of power. It must, therefore, be considered lasting as well as constant, economic, cleanly, and portable. Care should be taken to prevent the evaporation of the liquid in a hot climate like that of Malta.—ED. TEL. JOUR.

General Science Columns.

THE TOTAL ECLIPSE OF THE SUN which was visible over a belt of the south-western territories of the United States from Montana to Texas, on July 29, was well observed at all the different stations selected by astronomers. There are many indications of a remarkable change having taken place in the corona since 1871. Mr. Norman Lockyer telegraphs that the corona is found to change with the sun-spots. Professor Watson has discovered a new body of four and a half magnitudes, near the sun.

WE learn from *Nature* that Professor Tait is developing a very loud and economic fog signal, giving a noise similar to that of the drum, which is one of the most economical of sound alarms.

A NEW compressed-air fog signal has been erected on Cape Spear, Newfoundland. The blast will sound for seven seconds, once a minute, and will range from one and a half to ten miles, according to the state of the atmosphere.

A BED of fine lithographic stone has been discovered near Oran, in Algeria.

TASMANIAN TIN.—Tasmania is rapidly becoming a second Cornwall in the quality and extent of its tin supplies. Four years since, the value of tin and tin-ore exported from the colony was barely £7,000, while in 1877, the value of the tin exported was nearly £27,000. Until recently, the principal portion of the tin in Tasmania was obtained by the ancient process of "streaming," or washing the sand and earth in water, and allowing the heavier metallic parts to subside; but by the discovery of lodes at Mount Bischoff, the colonial miner has been enabled to compete on equal terms with his fellow craftsman in Cornwall. The mining district of Mount Bischoff has now found a rival in a tin mountain at Mount Humskirk, on the west coast. The "wash dirt" is some twenty feet thick, and produces about twenty-five per cent. of tin; but the existence of solid seams of the metal, traversing the mountains in veins several feet in depth and width, has thrown even these productive workings into the shade. Some "nuggets," weighing several cwts. each, have been found, yielding nearly cent. per cent. of pure tin. Mixed with the tin, too, is a small quantity of gold, which adds considerably to the tin miner's profit.—*Engineering*.

THE FRENCH METEOROLOGICAL SERVICE.—This service, founded by Leverrier, has just been separated from the Observatory of Paris, by a decree, dated May 14, 1878, and will soon be localised in a separate central bureau. It comprises the study of the movements of the atmosphere, meteorological warnings to ports and farmers, the organising of meteorological stations, and publication of useful data. The director is M. Mascart, professor in the College of France. The *Bulletin Internationale*, of the Observatory of Paris, will be the organ of the service, and will contain a synoptrical chart of barometric pressures, indicating also the wind, and the state of sky and sea; a chart of temperature, containing also the rainfall of the preceding day, and the storms signalled by despatches; the general condition of the day; warnings to sea-ports and agriculturists, and the observations made at Paris. A supplement will give the daily observations made during every month in the country and abroad. The reports from all Europe are centralised each day at Paris, and immediately utilised in order to transmit telegraphic warnings throughout the land. Among the names of the members recently appointed for three years to superintend the service, we notice those of M. Berthelot, M. I., who represents the Ministry of Public Instruction, and M. Blavier, telegraph engineer of the Government, to represent the French Postal Telegraph Administration.

City Notes.

Old Broad Street, August 14th, 1878.

AT the half-yearly meeting of the Anglo-American Company, Viscount Monck waxed jubilant at the cessation of "futile competition;" the same phrase was in the mouth of the chairman of the Direct United States Cable Company the same day. Thus the chairmen of both companies appear to be well satisfied that the amalgamation has already been fraught with benefit to each concern. There is one remark of Lord Monck's which deserves a word of entire praise. The noble chairman of the Anglo-American Company said at the meeting over which he presided, that he thought the state of their receipts, even under the present circumstances, bore out his opinion that there was room enough in the Atlantic for both the Direct and the Anglo Companies to make a good profit. Exactly; there is more than room enough. There is room enough in the Atlantic for another company to make a good profit. There might be room enough in the Atlantic for the Anglo-American and Direct Companies after a new company was formed, but they would have to reduce their tariff if they wished to make anything like good receipts. The sanguine anticipations of Lord Monck would be appropriate and safe if there did not exist the remotest chance that a rival company might, one fine morning, commence business. But surely Lord Monck cannot really imagine that the field of enterprise in which the shareholders of the Anglo-American Company are specially interested will never be invaded. Does he honestly believe that no capitalist, or body of capitalists, will ever dream of disturbing a system of monopoly which presses heavily upon all who have to use the American cables? Apart from the circumstance that the bright hopes of their chairman may be rudely dissipated at any moment, the shareholders of the Anglo Company, as we said in our last, have no particular reason to feel anxious. If their receipts are less than last half-year, is not the expenditure more? Is not the dividend the same as last year? Have not the directors agreed to spend £12,000 to £14,000 in order to increase the efficiency of the company's cables? No; it is clear, at any rate, that amalgamation has not proved the ruin of the Anglo-American Company. It was not intended to prove its salvation, was it? We forget.

But what of the Direct Company? "So long as they charged moderate rates," observed the chairman, "and reduced rates to the Press and the Government they would progress;" and he points triumphantly to the sum which has been added to the reserve fund. But £32,000 is not an immense sum, considering that there is no increase in the dividend. Mr. Pender was not at one time so easily pleased. Perhaps he looks more to "a great impulse of trade" for augmenting the company's receipts. We sincerely hope he does not look in vain; but now optimists who imagined that Peace would make all things right are beginning to doubt—in the face of the last revenue returns—whether trade will revive as they anticipated.

We must confess, however, we are surprised at the silence which was maintained, no less at the meeting of the Direct, than at that of the Anglo-American Company. Shareholders must, of course, be left to look after their own affairs, and if they are unwilling to raise a voice in their own defence, directors are justified in assuming that they have their full confidence.

As everything was smooth at the meetings of the Anglo-American and the Direct Companies, it followed that no storm ruffled the serenity of the proceedings at the subsequent meeting of the shareholders of the Globe Telegraph and Trust Company. The chairman read the report: remarked that the investments showed little change; that a dividend had actually been paid; that the value of Atlantic stock, and of their own shares, had improved; that their receipts had been augmented; that their expenses were a trifle higher—increase of receipts, and the payment of a dividend entailing inevitable and growing expense; that the revenue next year would be still greater; and that, finally, the prospects of Globe shareholders were pretty well all that could be desired. Having finished his speech, the chairman proposed the adoption of the report. It was seconded, and, after "a very brief discussion," carried, and the usual vote of thanks to the chairman and directors terminated the meeting. Our readers know what we think about the Globe Company. We have nothing to add to, or take from, what we deemed it necessary to say many months ago. We have only one remark to make in reference to the chairman's speech at the meeting. He has, at any rate, the courage of his convictions. He properly credited the Globe Company with bringing about "a working arrangement between the Atlantic Companies." We think we have given the Globe Company credit for the same thing. But the chairman added, "instead of leaving them (the Atlantic Companies) to do, by hostile competition, private rebates, and commissions, as much injury as possible to each other." Well, that is one way of looking at the matter—the way of a gentleman who has a considerable interest in the Globe Trust.

It is satisfactory to learn that the directors of the India Rubber, Gutta Percha, and Telegraph Works Company (Limited) are carrying forward as rapidly as possible the legal formalities necessary for the readjustment of the company's capital. Meanwhile, we find that the profit for the six months ending June 30, after charging all expenses and depreciations and providing for bad debts, is £23,494, making, in addition to the £21,055 brought forward from last year, a total balance in profit and loss account of £44,549. The directors recommend a distribution of an *interim* dividend for the half-year, payable on the 16th instant, of 25s. per £50 share, free of income-tax, being at the rate of 5 per cent. per annum. This will require £11,750, and the remainder of the balance is to be carried forward.

An extraordinary and important meeting of the shareholders of the Eastern Telegraph Company was held on the 9th instant in order to consider a proposal of the directors for the acquisition of the cable of the Black Sea Telegraph Company, the directors having in view the connection of the island of Cyprus with the existing lines of the company. The chairman of the Eastern Company warmly advocated the acquisition, and also the extension to Cyprus, and eventually moved a resolution approving the raising of what is estimated as sufficient money by the issue of debentures to the extent of £250,000. It was explained that the extension would cost £23,000 less than this sum, but the £23,000 would be devoted to surplus cable and stores. The debentures to be issued at five per cent. and to be offered *pro rata* to the shareholders. We are not surprised that the scheme was opposed, and we are bound to agree with the dissentients that the extension to Cyprus is rather unlikely to prove remunerative.

An extraordinary general meeting of the Indo-European Company is to be held on Friday week in order to consider, and possibly approve and authorise, the carrying out of a co-operative working agreement between the Indo-European Telegraph Department of Her Majesty's Indian Government, the Eastern Telegraph Company (Limited), and the Indo-European Company itself, relative to the division between the

three administrations of the revenue derived from the transmission of Indian and Trans-Indian messages. The meeting will also be empowered to pass such resolution or resolutions in regard thereto as may be approved.

The directors of the Cuba Submarine Telegraph Company report that the gross revenue for the six months ending 30th June last, including the balance brought forward from the last account, amounts to £18,278, and the expenditure to £15,920, leaving a net profit of £2,358. The unusually large expenditure arises entirely from the cost of the repair of the Cienfuegos-Santiago section of the original cable, amounting to £12,602, 4s. 2d., the ordinary expenses—amounting to £3,317—being rather less than usual. Considering that in the repair the cable has been renewed to the extent of 51¼ knots, the directors think they are warranted in charging the sum of £5,575 to the reserve fund. This sum, added to the balance of revenue account, will admit, after providing for the preference dividend, of a dividend on the ordinary shares at the rate of 6 per cent. per annum, leaving the sum of £133 to be carried forward to the current half-year's account, and they recommend that dividends be declared accordingly, payable 20th proximo.

Notice is given that the forty-second ordinary half-yearly general meeting of the Mediterranean Extension Telegraph Company, Limited, will be held at the City Terminus Hotel, on Wednesday, the 21st August, at twelve o'clock precisely, for the transaction of such business as shall be brought before it, including the declaration of a dividend, the election of two directors in the place of Sir J. R. Carmichael, Bart., chairman, and the Hon. Ashley Ponsonby, who retire by rotation, and of the Auditor, Mr. Allwright, who all being eligible, offer themselves for re-election. The Transfer Books will be closed from the 13th to the 21st inst., both inclusive.

The following are the latest quotations of telegraphs: Anglo-American, Limited, 61¼-61¾; Ditto, Preferred, 90-91; Ditto, Deferred, 34¼-34¾; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6⅝-6⅞; Cuba, Limited, 9¼-9¾; Cuba, Limited, 10 per cent. Preference, 16¾-17¼; Direct Spanish, Limited, 1-1¼; Direct Spanish, 10 per cent. Preference, 9⅝-10; Direct United States Cable, Limited, 1877, 13⅝-13⅞; Eastern, Limited, 7⅝-7⅞; Eastern, 6 per cent. Debentures repayable October 1883, 107-110; Eastern 5 per cent. Debentures repayable August, 1887, 101-102 xd.; Eastern 6 per cent. Preference, 11⅝-11⅞; Eastern Extension, Australasian and China, Limited, 7⅝-7⅞; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109 xd.; German Union Telegraph and Trust, 8¼-8¾; Globe Telegraph and Trust, Limited, 5¼-5½; Globe 6 per cent. Preference, 10¾-11; Great Northern, 8⅜-8⅝; Indo-European, Limited, 20½-21½; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 9¾-10¼; Reuter's Limited, 10-11; Submarine, 228-233; Submarine Scrip, 2-2½; West India and Panama, Limited, 2¼-2½; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited; 4½-4¾; Ditto, 6 per cent. Debentures "A," 94-97 xd., Ditto, ditto, ditto, "B," 92-95 xd.; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds, 114-118; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 30½-31; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2¾-3; India-Rubber and Gutta-Percha and Telegraph Works, Limited, 31-32.

As we expected, the speculators who were responsible for the "enthusiasm" which prevailed at a certain memorable meeting of Chatham and Dover shareholders and their friends, are now trying their hardest to get up another agitation, having for its object the carrying out of the dropped "fusion" scheme. But the shareholders of the South Eastern Company, at any rate, cannot be induced to take any interest in the matter. It will serve the persons right who forced up Chatham stock to a high price if they find their operations to have told against themselves. It is almost inconceivable that there should exist dupes who will be misled by this last impudent attempt to bamboozle the investing public.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£ *	£	£	£	£	£	£	£	£ k	£ k	£ *
July, 1878 ...	43,610	11,759	2,800	812	14,540	34,451	24,927	18,811	... ...	10,705	... ...	... ...	4,438
July, 1877 ...	38,790	9,329	2,954	823	14,820	42,713	22,224	19,187	... ...	9,943	1,925	7,883	4,980
Increase	4,820	2,430	... ...	... ...	... ...	... ...	2,703	... ...	... ...	762	... ...	... ...	... ...
Decrease	... ...	... ...	154	11	280	8,262	... ...	376	... ...	... ...	... ...	... ...	542

* Estimated. k Not yet published.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).

THE TELEGRAPHIC JOURNAL.

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THE BRITISH ASSOCIATION.

THE meeting of the Association which has just closed has certainly been a successful one. It is true that no papers of any striking merit have been read before the sections; scientific men, however, do not look to the British Association for the publication of important original discoveries, but rather as a pleasant reunion where old friends meet, new acquaintances are made, and pleasant excursions indulged in. Looked at from this point of view, there cannot be a doubt that the meeting has been an eminent success. The attendance has been, we believe, the third largest in the history of the Association. The hospitalities and the festivities have been unsurpassed, and the excursions have been most numerous and varied; indeed, it would almost appear as though the British Association meets more for the recreation of its members than for the advancement of science. Considering the fact that the majority of those attending the meetings of the Association have had no special training in science, but are interested and anxious to be instructed in its mysteries, we think the Council of the Association might devise some scheme whereby these annual gatherings could be made of wider interest and more permanent value. Every one who attends the meetings is familiar with the groups of men and women who wander aimlessly from section to section, eager to find something they can understand to carry away with them as a reminiscence of the sections they have attended; hence it comes to pass that when Sir John Lubbock discourses on ants, or Captain Burton on the land of Midian, or Miss Todd on the boarding out of pauper children, such sections become inconveniently overcrowded, full newspaper reports appear, and the public go away with the impression that such papers have been the chief events of the meeting. What the British Association really might do in the way of instructing the public in the progress of the different branches of science, it does not do, except so far as the evening lectures or the presidential addresses concern themselves with this topic. From various quarters similar remarks have been urged upon the Council of the Association; and we trust that, ere long, some action may be taken upon this important matter. Another matter demanding attention is the more expeditious publication of an authorative report of the proceedings of the sections, which, we imagine, might be done without any very great cost if undertaken in conjunction with the local newspaper press.

THE ROYAL DUBLIN SOCIETY CONVERSAZIONE.

One of the most striking features of the meeting was, perhaps, the brilliant and interesting *soirée* given by the Royal Dublin Society on August 15th. Space will not allow us to describe the numerous instruments exhibited and experiments that were shown, but, as concerns electrical apparatus, the most novel was a beautiful and complicated arrangement devised by Mr. J. E. H. Gordon, the newly-elected assistant secretary of the Association, for the purpose of measuring the specific inductive capacity of dielectrics. We may here say that Mr. Gordon employs an induction coil, the secondary current of which can be made and broken by a special contrivance with extreme rapidity, to maintain the constant electrification of one plate of the condenser, between the surfaces of which is placed the paraffin or other substance whose inductive capacity is to be determined.

Mr. Gordon, who also exhibited his electrical self-registering anemometer, had his instruments in actual working order at this *soirée*.

The President of the Association, Dr. Spottiswoode, sent for exhibition his apparatus for analysing the stratified discharge in vacuum tubes by means of a rotating mirror; also an arrangement for rapidly shifting the terminal from one end to another of a vacuum-tube, together with an apparatus for altering the resistance in the path of the secondary discharge, consisting of a long spiral glass tube, containing mercury in the lower part, and some liquid nonconductor above, the relative quantity of the two liquids being adjustable at pleasure. Dr. Spottiswoode also contributed one of Dr. Muirhead's large condensers, which, being once charged from a large induction coil, gives out a stream of electricity, illuminating a vacuum-tube for several minutes.

Mr. H. Yeates, of London, sent a very large induction coil, the secondary wire of which is unusually thick, and the spark particularly "fat."

Mr. S. Yeates, of Dublin, exhibited, at work, one of his new form of electrically controlled clocks, which is on the same system as Ritche's, but with the coil fixed, and the magnet forming the bob of the pendulum, both coil and magnet being of a different and better construction to those ordinarily in use.

Mr. Yeates also showed his ingenious and useful electrical rain gauge. Mr. Ladd brought an excellent form of Byrne's pneumatic bichromate of potash battery, adapted for surgical use; and also exhibited Edmund's phonoscope, an apparatus for making visible, by means of a rotating vacuum tube, the various vibrations imparted by the voice to the disc of a telephone. In this arrangement the iron telephone disc really forms the contact-breaker of a small induction coil, which is employed to illuminate a small vacuum tube kept in continuous rotation, thus presenting the appearance of the ordinary Gassiot star. When a sustained sound is uttered in front of the mouthpiece of the telephone, the star assumes a definite pattern, which varies when a note of different pitch is employed. Mr. Ladd also showed an electrical apparatus capable of reversing a current twenty-seven thousand times a minute.

In a separate room Mr. Stoney, the honorary secretary of the Royal Dublin Society, exhibited the beautiful absorption spectrum of chloro-chromic anhydride, with a spectroscope of unusually high dispersive power. In another room, Professor Barrett showed his discovery of the effect of entirely inaudible vibrations upon sensitive flames.

Mr. Wigham, of the well-known firm of Edmundson's, made different parts of the extensive and splendid buildings of the Royal Dublin Society brilliant with several electric lights derived from

Gramme machines driven by gas and steam engines. The same enterprising firm also sent a large model of the Galleyhead Lighthouse, and the piercing sounds of a gigantic Irish fog siren, sent by the same firm, were heard at intervals from the courtyard. Nor must we forget to mention the large punkah, swung by compressed air, the invention of Lord Rosse's brother, the Hon. R. C. Parsons, and the splendid show of carnivorous plants sent by Dr. Moore, from the Dublin Botanical Gardens.

Electro-type reproductions of all the most interesting objects in the loan collection of scientific apparatus were lent by the authorities of the South Kensington Museum, together with several cases of interesting art objects. A vast array of microscopes, with some remarkable microscopic objects, were exhibited by different members of the Dublin Microscopic Club, and lastly, a fine display of art objects and of exotic plants, lent by local friends, embellished the various rooms.

ADDRESS OF WILLIAM SPOTTISWOODE, ESQ., M.A., D.C.L., L.L.D., F.R.S., F.R.A.S., F.R.G.S., PRESIDENT.

(Continued from page 341.)

Now the process whereby we have passed from the possible to the impossible, and again repassed to the possible (namely, the shifting of the starting point) is a perfectly continuous one, while the conditions of the problem as stated above have abruptly changed. If, however, we replace the idea of a line touching by that of a line cutting the circle, and the distance of the point of contact by the distances at which the line is intercepted by the curve, it will easily be seen that the latter includes the former as a limiting case, when the cutting line is turned about the starting point until it coincides with the tangent itself. And further, that the two intercepts have a perfectly distinct and intelligible meaning whether the point be outside or inside the area. The only difference is that in the first case the intercepts are measured in the same direction; in the latter in opposite directions.

The foregoing instance has shown one purpose which these imaginaries may serve, viz., as marks indicating a limit to a particular condition of things, to the application of a particular law, or pointing out a stage where a more comprehensive law is required. To attain to such a law we must, as in the instance of the circle and tangent, reconsider our statement of the problem; we must go back to the principle from which we set out, and ascertain whether it may not be modified or enlarged. And even if in any particular investigation, wherein imaginaries have occurred, the most comprehensive statement of the problem of which we are at present capable fails to give an actual representation of these quantities; if they must for the present be relegated to the category of imaginaries; it still does not follow that we may not at some future time find a law which will endow them with reality, nor that in the meantime we need hesitate to employ them, in accordance with the great principle of continuity, for bringing out correct results.

If, moreover, both in Geometry and in Algebra we occasionally make use of points or of quantities, which from our present outlook have no real existence, which can neither be delineated in space of which we have experience, nor measured by scale as we count measurement; if these imaginaries, as they are termed, are called up by legitimate processes of our science; if they serve the purpose not merely of suggesting ideas, but of actually conducting us to practical conclusions; if all this be true in abstract science, I may perhaps be allowed to point out, in illustration of my argument, that in Art unreal forms are frequently used for suggesting ideas, for conveying a meaning for which no others seem to be suitable or adequate. Are not forms unknown to Biology, situations incompatible with gravitation, positions which challenge not merely the stability but even the possibility of equilibrium—are not these the very means to which the artist often has recourse in order to convey his meaning and to fulfil his mission? Who that has ever revelled in the ornamentation of the Renaissance, in the extraordinary transitions from the animal to the vegetable, from faunic to floral forms, and from these again to almost purely geometric curves, who has not felt that these imaginaries have a claim to recognition very similar to that of their congeners in mathematics? How is it that the grotesque paintings of the Middle Ages, the fantastic sculpture of remote nations, and even the rude art of the pre-historic past, still impress us, and have an interest over and above their antiquarian value; unless it be that they are symbols which, although hard of interpretation when taken alone, are yet capable from a more comprehensive point of view of leading us mentally to something beyond themselves, and to truths which, although reached through them, have a reality scarcely to be attributed to their outward forms?

Again, if we turn from Art to Letters, truth to nature and to fact is undoubtedly a characteristic of sterling literature; and yet in the delineation of outward nature itself, still more in that of feelings and affections, of the secret parts of character and motives of conduct, it frequently happens that the writer is driven to imagery, to an analogy, or even to a paradox, in order to give utterance to that of which there is no direct counterpart in recognised speech. And yet which of us cannot find a meaning for these literary figures, an inward response to imaginative poetry, to social fiction, or even to those tales of giant and fairyland written, it is supposed, only for the nursery or schoolroom? But in order thus to reanimate these things with a meaning beyond that of the mere words, have we not to reconsider our first position, to enlarge the ideas with which we started; have we not to cast about for some thing which is common to the idea conveyed and to the subject actually described, and to seek for the sympathetic spring which underlies both; have we not, like the mathematician, to go back as it were to some first principles, or, as it is pleasanter to describe it, to become again as a little child?

Passing to the second of the three methods, viz., that of Manifold Space, it may first be remarked that our whole experience of space is in three dimensions, viz., of that which has length, breadth, and thickness; and if for certain purposes we restrict our ideas to two dimensions as in plane geometry, or to one dimension as in the division of a straight line, we do this only by consciously and of deliberate purpose setting aside, but not annihilating, the remaining one or two dimensions. Negation, as Hegel has justly remarked, implies that which is negatived, or, as he expresses it, affirms the opposite. It is by abstraction from previous experience, by a limitation of its results, and not by any independent process, that we arrive at the idea of space whose dimensions are less than three.

It is doubtless on this account that problems in plane geometry which, although capable of solution on their own account, become much more intelligible, more easy of extension, if viewed in connexion with solid space, and as special cases of corresponding problems in solid geometry. So eminently is this the case, that the very language of the more general method often leads us almost intuitively to conclusions which, from the more restricted point of view, require long and laborious proof. Such a change in the base of operations has, in fact, been successfully made in geometry of two dimensions, and although

we have not the same experimental data for the further steps, yet neither the modes of reasoning, nor the validity of its conclusions, are in any way affected by applying an analogous mental process to geometry of three dimensions; and by regarding figures in space of three dimensions as sections of figures in space of four, in the same way that figures in plano are sometimes considered as sections of figures in solid space. The addition of a fourth dimension to space not only extends the actual properties of geometrical figures, but it also adds new properties which are often useful for the purposes of transformation or of proof. Thus it has recently been shown that in four dimensions a closed material shell could be turned inside out by simple flexure, without either stretching or tearing; and that in such a space it is impossible to tie a knot.

Again, the solution of problems in geometry is often effected by means of algebra; and as three measurements, or co-ordinates, as they are called, determine the position of a point in space, so do three letters or measurable quantities serve for the same purpose in the language of algebra. Now, many algebraical problems involving three unknown or variable quantities admit of being generalised so as to give problems involving many such quantities. And as, on the one hand, to every algebraical problem involving unknown quantities or variables by ones, or by twos, or by threes, there corresponds a problem in geometry of one or of two or of three dimensions; so on the other it may be said that to every algebraical problem involving many variables there corresponds a problem in geometry of many dimensions.

There is, however, another aspect under which even ordinary space presents to us a four-fold, or indeed a manifold, character. In modern Physics, space is regarded not as a vacuum in which bodies are placed and forces have play, but rather as a plenum with which matter is co-extensive. And from a physical point of view the properties of space are the properties of matter, or of the medium which fills it. Similarly from a mathematical point of view, space may be regarded as a *locus in quo*, as a plenum, filled with those elements of geometrical magnitude which we take as fundamental. These elements need not always be the same. For different purposes different elements may be chosen; and upon the degree of complexity of the subject of our choice will depend the internal structure or mani-foldness of space.

Thus, beginning with the simplest case, a point may have any singly infinite multitude of positions in a line, which gives a one-fold system of points in a line. The line may revolve in a plane about any one of its points, giving a two-fold system of points in a plane; and the plane may revolve about any one of the lines, giving a three-fold system of points in space.

Suppose, however, that we take a straight line as our element, and conceive space as filled with such lines. This will be the case if we take two planes, *e.g.*, two parallel planes, and join every point in one with every point in the other. Now the points in a plane form a two-fold system, and it therefore follows that the system of lines is four-fold; in other words, space regarded as a plenum of lines is four-fold. The same result follows from the consideration that the lines in a plane, and the planes through a point, are each two-fold.

Again, if we take a sphere as our element, we can through any point as a centre draw a singly infinite number of spheres, but the number of such centres is triply infinite: hence space as a plenum of spheres is four-fold. And, generally, space as a plenum of surface has a manifoldness equal to the number of constants required to determine the surface. Although it would be beyond our present purpose to attempt to pursue the subject further, it should not pass unnoticed that the identity in the four-fold character of space, as derived on the one hand from a system of straight lines, and on the other from a system of spheres, is intimately connected with the principles established by Sophus Lie in his researches on the correlation of these figures.

If we take a circle as our element we can around any point in a plane as a centre draw a singly infinite system of circles; but the number of such centres in a plane is doubly infinite; hence the circles in a plane form a three-fold system, and as the planes in space form a three-fold system, it follows that space as a plenum of circles is six-fold.

Again, if we take a circle as our element, we may regard it as a section either of a sphere or of a right cone (given except in position) by a plane perpendicular to the axis. In the former case the position of the centre is three-fold; the directions of a plane, like that of a pencil of lines perpendicular thereto, two-fold; and the radius of the sphere one-fold; six-fold in all. In the latter case, the position of the vertex is three-fold; the direction of the axis two-fold; and the distance of the plane of section one-fold, six-fold in all, as before. Hence space as a plenum of circles is six-fold.

Similarly, if we take a conic as our element we may regard it as a section of a right cone (given except in position) by a plane. If the nature of the conic be defined, the plane of section will be inclined at a fixed angle to the axis; otherwise it will be free to take any inclination whatever. This being so, the position of the vertex will be three-fold; the direction of the axis two-fold; the distance of the plane of section from the vertex one-fold; and the direction of that plane one-fold if the conic be defined, two-fold if it be not defined. Hence, space as a plenum of definite conics will be seven-fold, as a plenum of conics in general eight-fold. And so on for curves of higher degrees.

This is, in fact, the whole story and mystery of manifold space. It is not seriously regarded as a reality in the same sense as ordinary space; it is a mode of representation, or a method which, having served its purpose, vanishes from the scene. Like a rainbow, if we try to grasp it, it eludes our very touch; but, like a rainbow, it arises out of real conditions of known and tangible quantities, and if rightly apprehended it is a true and valuable expression of natural laws, and serves a definite purpose in the science of which it forms part.

Again, if we seek a counterpart of this in common life, I might remind you that perspective in drawing is itself a method not altogether dissimilar to that of which I have been speaking; and that the third dimension of space, as represented in a picture, has its origin in the painter's mind, and is due to his skill, but has no real existence upon the canvas which is the groundwork of his art. Or again, turning to literature, when in legendary tales, or in works of fiction, things past and future are pictured as present, has not the poetic fancy correlated time with the three dimensions of space, and brought all alike to a common focus? Or once more, when space already filled with material substances is mentally peopled with immaterial beings, may not the imagination be regarded as having added a new element to the capacity of space, a fourth dimension of which there is no evidence in experimental fact?

The third method proposed for special remark is that which has been termed Non-Euclidean Geometry; and the train of reasoning which has led to it may be described in general terms as follows: some of the properties of space which on account of their simplicity, theoretical as well as practical, have, in constructing the ordinary system of geometry, been considered as fundamental, are now seen to be particular cases of more general properties. Thus a plane surface, and a straight line, may be regarded as special instances of surfaces and lines whose curvature is everywhere uniform or constant. And it is perhaps not difficult to see that, when the special notions of flatness and straightness are abandoned, many properties of geometrical figures which we are in the habit of

regarding as fundamental will undergo profound modification. Thus a plane may be considered as a special case of the sphere, viz., the limit to which a sphere approaches when its radius is increased without limit. But even this consideration trenches upon an elementary proposition relating to one of the simplest of geometrical figures. In plane triangles the interior angles are together equal to two right angles; but in triangles traced on the surface of a sphere this proposition does not hold good. To this, other instances might be added.

Further, these modifications may affect not only our ideas of particular geometrical figures, but the very axioms of the Science itself. Thus, the idea, which in fact lies at the foundation of Euclid's method, viz., that a geometrical figure may be moved in space without change of size or alteration of form, entirely falls away, or becomes only approximate in a space wherein dimension and form are dependent upon position. For instance, if we consider merely the case of figures traced on a flattened globe like the earth's surface, or upon an eggshell, such figures cannot be made to slide upon the surface without change of form, as is the case with figures traced upon a plane or even upon a sphere. But, further still, these generalisations are not restricted to the case of figures traced upon a surface; they may apply also to solid figures in a space whose very configuration varies from point to point. We may, for instance imagine a space in which our rule or scale of measurement varies as it extends, or as it moves about, in one direction or another; a space, in fact, whose geometric density is not uniformly distributed. Thus we might picture to ourselves such a space as a field having a more or less complicated distribution of temperature, and our scale as a rod instantaneously susceptible of expansion or contraction under the influence of heat: or we might suppose space to be even crystalline in its geometric formation, and our scale and measuring instruments to accept the structure of the locality in which they are applied. These ideas are doubtless difficult of apprehension, at all events at the outset; but Helmholtz has pointed out a very familiar phenomenon which may be regarded as a diagram of such a kind of space. The picture formed by reflection from a plane mirror may be taken as a correct representation of ordinary space, in which subject to the usual laws of perspective, every object appears in the same form and of the same dimensions whatever be its position. In like manner the picture formed by reflection from a curved mirror may be regarded as the representation of a space wherein dimension and form are dependent upon position. Thus in an ordinary convex mirror objects appear smaller as they recede laterally from the centre of the picture; straight lines become curved; objects infinitely distant in front of the mirror appear at a distance only equal to the focal length behind. And by suitable modifications in the curvature of the mirror, representations could similarly be obtained of space of various configurations.

The diversity in kind of these spaces is of course infinite; they vary with the mode in which we generalise our conceptions of ordinary space; but upon each as a basis it is possible to construct a consistent system of geometry, whose laws, as a matter of strict reasoning, have a validity and truth not inferior to those with which we are habitually familiar. Such systems having been actually constructed the question has not unnaturally been asked, whether there is anything in nature or in the outer world to which they correspond; whether, admitting that for our limited experience ordinary geometry amply suffices, we may understand that for powers more extensive in range or more minute in definition some more general scheme would be requisite? Thus, for example, although the one may serve for the solar system, is it legitimate to suppose that it may fail to apply at distances reaching to the fixed stars, or to regions beyond? Or, again, if our vision could discern the minute configurations of portions of space, which to our ordinary powers appear infinitesimally small, should we expect to find that all our usual Geometry is but a special case, sufficient indeed for daily use, but after all only a rough approximation to a truer although perhaps more complicated scheme? Traces of these questions are in fact to be found in the writings of some of our greatest and most original mathematicians. Gauss, Riemann, and Helmholtz have thrown out suggestions radiating as it were in these various directions from a common centre; while Cayley, Sylvester, and Clifford in this country, Klein in Germany, Lobatcheffsky in Russia, Bolyai in Hungary, and Beltrami in Italy, with many others have reflected kindred ideas with all the modifications due to the chromatic dispersion of their individual minds. But to the main question the answer must be in the negative. And, to use the words of Newton, since "Geometry has its foundation in mechanical practice," the same must be the answer until our experience is different from what it now is. And yet, all this notwithstanding, generalised conceptions of space are not without their practical utility. The principle of representing space of one kind by that of another, and figures belonging to one by their analogues in the other, is not only recognised as legitimate in pure mathematics, but has long ago found its application in cartography. In maps or charts, geographical positions, the contour of coasts, and other features, belonging in reality to the Earth's surface, are represented on the flat; and to each mode of representation, or projection as it is called, there corresponds a special correlation between the spheroid and the plane. To this might perhaps be added, the method of descriptive geometry, and all similar processes in use by engineers, both military and civil.

(To be continued.)

MOTIONS PRODUCED BY DILUTE ACIDS ON SOME AMALGAM SURFACES.

By ROBERT SABINE.

Abstract of paper read before the British Association, at Dublin, August 15th.

THE author finds, when a drop of very dilute acid is placed upon the clean and newly filtered surface of a rather rich amalgam of some metal which is positive to mercury, that the drop does not lie still, as it would do upon pure mercury, but sets itself into an irregular jerky motion. This is the case with copper, zinc, antimony, tin, and lead amalgams. But if, instead of these amalgams, those of platinum, gold, and silver are used—these latter metals being negative to mercury—the drop of acid-water lies quite still. The acids tried were sulphuric, hydrochloric, oxalic, and acetic, which behaved similarly but in different degrees.

When the experiment is made in an atmosphere of oxygen, the movements upon the amalgams of the positive metals are increased; but in hydrogen, carbonic-acid, nitrogen, and coal-gas, the motions are instantly arrested.

The author concludes that the motions result from an alternate play of deoxidation of the mercury underneath the acid by electrolysis, due to the currents of small floating particles of the positive metal, causing the drop to contract, and of oxidation of the surface outside the acid drop, causing it to re-expand.

ON RECENT ADVANCES IN TELEGRAPHY.

By WILLIAM HENRY PREECE, Mem. Inst. C.E., &c., &c.

Read before the British Association at Dublin, August 19, 1878.

The overpowering sensation produced by the telephone and other acoustic instruments that have followed in its wake has led many people to imagine that improvement in telegraphy has ceased, at least in this country. It has been publicly stated by very high authorities that, since the transfer of the telegraphs to the State, invention in that art has left the shores of the United Kingdom and flown to those of America. Moreover, it has been intimated that the monopoly in telegraphy possessed by the State has checked improvement.

Such statements are made in ignorance of the facts. Greater improvements have been made in telegraphy during the past eight years than in any previous period of similar duration. Inventions have, it is true, found their way from America; but they have also travelled in the opposite direction, and have taken root there. Indeed, improvement in telegraphy was never more active in England than it has been since the Government has managed the business.

The object of this paper is to prove the above propositions.

Taking the improvements that have been made in telegraphs generally during recent periods, I will first of all deal with the receiving apparatus. The general feature of the apparatus used in Europe was eight years ago dependent on sight, while in America it was dependent on sound. In England we had (1) the needle instrument of Cooke and Wheatstone, which was and is still universally employed on our railways; (2) the Morse recording instrument, which is still the most generally-used instrument throughout Continental Europe; (3) the Hughes type printer; (4) the A B C or alphabetical instrument of Wheatstone; and (5) the bell instrument of Bright.

In America, though the type printer has been very largely used, the principal instrument for many years past has been the sounder.

The gradual exercise of that law of evolution—the survival of the fittest—is in England slowly replacing the Morse recorder by the more simple sounder. It has removed the type printer excepting in connexion with cables to the Continent. It has commenced to supplant the needles, which appeal to the eye by a method which appeals to the ears, in fact, a modified form of the bell—the first sound instrument ever introduced—and its general tendency is to reduce all apparatus to one stage of uniformity. Acoustic apparatus has proved itself to be more simple, more accurate, and more expeditious than visual apparatus, but its capacity is limited to the rate at which the ear can comprehend signals. Again, the speed is limited by that at which the hand can send and write, and the operations of sending at one end and writing at the other must be simultaneous, while recorded messages can wait, or they can be distributed among several writers. Hence all apparatus fixed on fast-speed circuits must necessarily remain visual, while all other ordinary apparatus will probably be acoustic.

The principal improvements that have been recently introduced in receiving apparatus have been S. A. Varley's and Spagnoletti's induced needles, to remedy the disturbances due to atmospheric electricity; Siemens' direct ink-writer, to remedy the irksomeness to the eye of the embossed paper of Morse; Wheatstone's A B C dial instrument, Sir W. Thomson's syphon recorder, and Varley's condenser, both of these being designed for expediting the rate of working through long submarine cables.

Bain's chemical recorder (reproduced after many years interment) for expediting the speed of automatic working through long circuits.

Neale's acoustic coil for assimilating the single needle and bell systems.

Bell's telephone, which, however, is at present employed only on a very limited scale in England.

With respect to sources of electricity. Innumerable improvements have been made in batteries, but two only need be named, which, for power, efficiency, and economy, far surpass all others, and are being very considerably employed in the United Kingdom, viz.:—

Leclanché's, where ammonic chloride and manganic peroxide are the principal exciting agents, and Fuller's, where Poggendorff's potassic bichromate solution is the exciting agent.

These two batteries are gradually replacing with great economy the Daniell form, hitherto so largely used.

In sources dependent upon motion in a magnetic field, such as Wild's, Siemens', and Gramme's machines, though experiments have been made, they have not yet shown themselves equal in efficiency to batteries for telegraphic purposes.

It seems, however, very desirable that so simple a form of energy as the motion of a steam engine or a turbine should be utilised as an electric machine, since probably it is the most economical form by which the necessary conversion can be made. In batteries the waste of energy is enormous.

In sources dependent on the conversion of heat into electricity, Clamond's thermo-electric pile, both in its original form and as modified by Leonard Wray, have been extensively experimented upon, but without any decided result. It is, however, worthy of record that for many weeks forty-three circuits were maintained in working order by one pile, in which the energy of gas jets was converted into currents of electricity.

It is perhaps in improvements in conductors that England has shone most. She has supplied the world with cables.

Her iron-clad ropes rest on the bottom of every sea, and her cable fleet is seen nearly everywhere. The Post Office alone possesses sixty-two cables, embracing 1,060 miles.

In the manufacture of iron wire England stands pre-eminent. Messrs. Johnson, of Manchester, have led the way with their continuous "rolling" method.

Our moist climate, smoky atmosphere, winter fogs, and salt-sprayed land have proved a sad source of trouble in insulating our wires. Messrs. Clark, Varley, Andrews, and many others have battled against these difficulties in vain. Several improvements are now under trial, such as Cordeaux's, to facilitate cleaning, Fuller's, to increase resistance, and Messrs. Johnson and Phillips', who have struck

out quite a new line by inserting a section of oil in the path of the current. Indeed, we are always experimenting in this direction. The higher classed apparatus that is being introduced needs higher classed insulation. The difficulties of this country are not experienced elsewhere, and therefore our efforts to cure the evil are not appreciated. The form that is found perfect in America failed miserably in England, and those accepted on the Continent are not to be compared to those in use here, when erected under similar conditions.

It is, perhaps, in the sending department that the greatest changes have been made.

Varley's double-current system, working with polarized relays, has survived all others; but the keys used in working it, which at first were cumbrous, and therefore slow in action, have been revolutionised by Mr. Stroh, and by the Post Office electricians. Keys manipulated by hand cannot be made to send more than forty-five words per minute, whereas the limit of recorders far exceeds this. Moreover, the hand soon tires, and cannot maintain the speed. Indeed, the average rate of sending of the best operator does not exceed thirty words a-minute.

Alexander Bain, in 1843, proposed to replace hand-keying by automatic sending, and thus to attain much higher speed. But Bain was before his time; there was not business enough to fill a wire, hence the system remained in abeyance. It was taken up again by Wheatstone, in 1868, when the necessity for improved methods began to be evident. This system has been very extensively employed by the Post Office, and at the present moment there are over 170 instruments worked. Indeed, without its aid it would have been impossible to have coped with the enormous amount of news which the cheap tariff thrust on the Post Office wires. Wheatstone's apparatus has been entirely remodelled and improved by the Post Office electricians. Nothing but the original idea remains, and the machine now turned out by Mr. Stroh is one of the most perfect pieces of mechanism employed in any art.

The telephone bids fair some day to be of use in some branches of telegraphy, but its progress has been disappointingly small, and its employment has been checked by the outrageous terms demanded.

The changes and improvements that have been made in the sending apparatus have been accompanied by equal improvements in the speed of working in the receiving apparatus. The laws of induction on wires and in instruments, the causes of retardation in working on long lines and submarine cables, have been carefully studied by English electricians, and means have been devised to reduce or remove the deteriorating influences. The currents sent to produce signals are varied in their form, so as to roll into one another and to become indistinguishable. While on a short line it is possible to attain 1,000 words a minute, or more, the rate of working rapidly diminishes with distance, and between London and Dublin it was difficult to maintain more than seventy words a minute. Modes of compensating upon the line itself the currents sent by the Wheatstone transmitter, and of connecting up the coils so as to eliminate the effects of currents induced in them, have been successfully introduced by the Post Office electricians, so as to increase the rate of working on long lines very considerably; and very recently, relays of exquisite manufacture have been constructed which, inserted as translating relays or repeaters at intermediate points, have still further increased the rate of working on automatic circuits between London and Dublin fifty per cent. Indeed, while the question of increased telegraphic communication between Ireland and England was under consideration, this more rapid mode of working solved the question. It has in some instances increased the rate of working over 100 per cent.

Bain's original chemical recorder has been resuscitated, but its use is attended with disadvantages which have not led to its extended employment. It is in use in Dublin.

Bain's recorder has also been resuscitated in America. Mr. Little applied to it a condenser as a shunt to prevent the confusion or running together of signals, due to induction on the line when running at high speed. He called it "an overflow dam." Mr. Edison effected the same thing in a better way by using an adjustable electro-magnet as a shunt. Immense speed was attained by this means.

It will thus be seen that the distinguishing feature that has characterised the improvements made by the Post Office officials has been in the direction of fast-speed telegraphy; and it is not too much to say that they have more than quadrupled the working speed of wires.

The improvements made towards increasing the capacity of wires is wonderful.

There are now in England nearly 200 duplex circuits worked, and our ocean cables, by the aid of peculiar condensers, introduced by Muirhead and Taylor, are gradually being duplexed.

Quadruplex telegraphy was suggested by Bosscha and Stark, in 1855, and by Mr. Oliver Heaviside, in 1873. It was patented in this country by Mr. Stearns, in 1874. It was devised by Mr. Walby, a Post Office official in Dublin, also in 1873. It was, however, for the first time put into practical operation by Messrs. Edison and Gerritt Smith, in 1876, upon the lines of the Western Union Telegraph Company in America, where it is now applied to sixty circuits. It is now being introduced by the Post Office. It works perfectly on short lines, but it becomes troublesome on long lengths.

It is capable of considerable extension and variation. In America it works to distances exceeding 1,000 miles by means of relays or repeaters fixed about the centre of the circuit. Thus New York works to St. Louis with relays in at Pittsburg. At the present time West Hartlepool and Middlesborough are each working duplex to London—on separate wires to Leeds, but on the same wire to London.

Telephone currents are very minute currents following each other with great rapidity, and they can be superposed on ordinary working currents without interfering with their action on ordinary telegraphic apparatus. Mr. Cromwell Varley utilised this principle in 1870, by patenting what we may call *harmonic* telegraphy, but it remained for Mr. Elisha Gray, of Chicago, to work the system out practically. He utilises the wires employed for serving "way" or intermediate stations, by working them also harmonically between their terminal points, thus vastly increasing their capacity. This system is now under trial in America.

Other systems for increasing the capacity of wires have also been devised on the Continent. Thus Meyer (whose instrument was exhibited at the Vienna Exhibition of 1873, and is now in use on a small scale in France and Austria) sends four messages in the same direction apparently at the same time; but they are not sent simultaneously, the signals are divided and distributed so as to obtain the maximum carrying capacity of the wire, and therefore the practical gain is not great.

M. Baudot, whose apparatus is exhibited at the Paris Exhibition, sends five messages upon the Hughes apparatus in the same direction, but they also are not simultaneous, and though by utilising the intervals of time occupied by the type wheel in revolving and distributing the signals, he increases the capacity of the wire, the gain is not very evident. The instrument is very complicated, and its practical success questionable.

The French Government is also trying an automatic system of type printing, devised by M. Olsen, which is said to increase the capacity of the Hughes type printer 33 per cent.

Now of all these systems, the most valuable, successful, and practical, are the Wheatstone Automatic and the Quadruplex. The average speed attained on the Automatic, on an average circuit worked simplex, is 100 words per minute, which becomes 200 words per minute when worked duplex. The average speed attained on the Quadruplex is 120 words per minute. Hence, when duplexed, Automatic is more capacious than the Quadruplex, but the elasticity of the Quadruplex makes it a valuable help to the Automatic system, and when the two are combined (which has recently been done by the electricians of the Post Office) the advantages of both are secured. One side of the Quadruplex is worked automatically, and the other side by ordinary keying.

But it must be remembered that each system has its disadvantages—principally the employment of a more highly trained staff. The Automatic system involves previous preparation, and therefore preliminary delay. The complication and delicacy of both systems involve better-maintained lines, and their failure tends to much greater trouble. There is a distance within which each becomes disadvantageous and expensive, and where it is cheaper and better to erect extra wires.

Now these systems of fast-speed and multiplex telegraphy have grown up in England under the fostering care of the Post Office since the transfer of the telegraphs to the State, and therefore I contend that I am justified in saying that greater improvements have been made in telegraphy during the past eight years than in any previous period of similar duration.

Necessity drove the Americans to the introduction of quadruplex telegraphy, as it drove us to the employment of the automatic system. The increased business demanded increased capacity of wires. Automatic telegraphy in America was in the hands of opponents. All the skill of the Western Union Telegraph Company was devoted to the improvement of multiplex telegraphy, and the quadruplex is the result. Neither duplex nor quadruplex telegraphy were, however, invented in America. They were imported there, but in a very crude condition. The great practical skill and ingenuity of our cousins made them what they are—the most valuable adjuncts to telegraphy.

It will be observed that in the above enumeration England stands prominent as the home of the inventor. While she can boast of Wheatstone, Cooke, Bain, Thomson, Clark, Varley, Fuller, &c., and Europe can boast of Gintl, Siemens, Frischen, Meyer, &c., America has her Morse, Hughes, Stearns, Edison, and Gray.

In 1868 the Western Union Telegraph Company, feeling that their telegraphic system was not up to the requirements of the age, secured the valuable services of Mr. Cromwell Varley, who educated them up to the Europern standard of electrical knowledge, and they have certainly bettered their instruction.

America has freely adopted our system of pneumatic telegraphy. They have introduced our methods of testing. They have adopted Johnson's method of manufacturing iron wire. They have introduced on some lines automatic telegraphy, modified by Messrs. Little and Edison. They are trying our superior batteries.

Hence, while we have not been slow to avail ourselves of their advances, they have equally availed themselves of our progress.

Telegraphy is thus cosmopolitan. Whatever of value and advance is produced in one nation is adopted by all. Invention has not left the shores of England. The English Telegraph Department stands in the front rank. Foreign Governments freely avail themselves of our experience. Our models, our plans, and our manufactures are found in every clime.

It remains for me to say a few words as to the part played by the Post Office in fostering these advances. The system of news wires is unique in its kind. Forty-seven news circuits and twenty-two special wires are made up every day for the transmission of intelligence. News is transmitted direct from London to every town in the United Kingdom at which a daily paper is published.

This is maintained by the automatic system. Half a million words are frequently sent in one night from London alone. When Lord Beaconsfield gave his address in the House of Lords on the results of the Berlin Congress, 526,250 words were transmitted from T.S. the central station.

There is not a branch of the service that has not been improved. New batteries, new insulators, preserved poles, improved wires, the most perfect relays, and multiplex apparatus have all found their way into the Post Office service. In 1873, 15,535,780 messages were transmitted over 105,285 miles of wire, being an average of 147 messages per mile of wire, while in 1878, 22,171,783 were sent over 113,333 miles of wire, being an average of 200 messages per mile of wire. Of the 8,000 miles of additional wire which have been put up, more than one-half is for *private* wire purposes; therefore the message average is really even higher than that given. Indeed, only 4,000 miles of wire have been erected to transmit nearly 7,000,000 messages, or an increase of nearly 50 per cent. of work.

No one has ever been heard to complain of the Post Office in adopting improvements but perhaps some disappointed inventor. It must be remembered that improvement is invariably the result of inventive power combined with practical experience, well

tempered with theoretical knowledge. Practical inventions rarely emanate from without. The long list that I have enumerated is, without exception, composed of men who have possessed these qualifications; but the great majority of patents are taken out by those who do not possess them at all. They are the most troublesome men to deal with. They cannot be convinced of their errors, and their want of experience prevents them from seeing their failure; but of the numerous patents that are annually taken out, how many complaints are made by those who have not been fairly and properly treated? The following table gives a list of patents which have been taken out for improvements in telegraphy for each year since 1862.

IMPROVEMENTS IN TELGRAPHY.

YEAR.	1	2	3	4	TOTAL.
1862	29	9	7	6	51
1863	13	7	8	3	31
1864	24	3	3	3	33
1865	24	27	8	7	66
1866	25	13	7	9	54
1867	39	7	4	4	54
1868	31	5	6	7	49
1869	28	11	3	6	38 Average. ——48¼
1870	26	5	4	4	39
1871	17	3	4	10	34
1872	50	5	3	4	62
1873	49	5	2	6	62
1874	50	13	2	2	67
1875	25	12	2	2	41
1876	35	25	3	3	66
1877	42	3	—	1	46 Average. ——32⅛

NOTE.—Column 1 contains the number of Patents which refer exclusively to land lines.

Column 2 those which refer exclusively to submarine work.

Column 3 gives the Patents which refer to the manufacture of Telegraph material.

Column 4 gives those Patents which bear partially upon Telegraphy, and partly on other arrangements to which such inventions are also applicable.

They are thus now as numerous as ever, indeed, the average of the last eight years exceeds that of the previous eight; hence I am justified in saying that the possession of the telegraphs by the State has not checked improvement. Moreover, the telegraph system outside that of the Government is as great now as the whole telegraph system of the country was before the transfer, and inventors, if they are dissatisfied with the Government, have the numerous cable companies and the great railway systems of this country to fall back upon. Private enterprise is not dead.

The fact remains that telegraphy, whether for commercial or railway purposes, is more highly developed in England than in any other country, not excepting America, and this development is due as much to the action of the State in purchasing and managing the commercial system of the country as to the competition that remains between nation and nation and between company and company. The lines of the Post Office are now worked with a view to a fair commercial profit as much as any private concern. The action of the Governments in all departments is jealously watched by its master, the public. The master is not always just, nor generous. Its prerogative is to find fault with the Government in all that it does, and it is well that this right be exercised, for it forms a very valuable check on abuse, it strengthens discipline, and it secures a worthy discharge of duty.

I can speak from the experience of a commercial and of a Governmental department extending over twenty-five years, and I have no hesitation whatever in asserting that there is as much zeal, energy, and enterprise in the one as there is in the other. The control of Parliament and of the Press exercises a far more disciplinary and supervising power on the management of a Government Department than any half-yearly meeting of shareholders or occasional committee of investigation.

[One or two important papers read before the British Association we are compelled to leave over until the next issue.]

NEW APPLICATIONS OF THE MICROPHONE.

I. *The microphone in experiments.*—Step by step the telephone has become useful, not only as a practical tool, but as an experimental apparatus; and we are now able to record a similar advancement of the microphone. It is interesting to learn that Mr. Chandler Roberts, F.R.S., has successfully employed it in rendering the diffusion of the molecules of gases through a porous septum or partition, plainly audible. A more important application of it, however, has recently been made by Professor Hughes himself. He has just used it to settle, in a conclusive manner, the controversy which has been actively going on of late between Colonel Navez, of Belgium, and the Count du Moncel, respecting the true explanation of the physical action of the articulating telephone. It will be remembered that Professor Bell, in his address to the Society of Telegraph Engineers on the telephone last year, threw out the suggestion that the sounds given out by the telephone were due as much to molecular as to mechanical vibrations of the diaphragm. He was led to this conclusion by the fact that iron diaphragms so thick that they could not bend bodily under the varying magnetic attraction of the magnet of the telephone, were found to give out articulate sounds. The subsequent discoveries of Mr. Blyth and others, that diaphragms, not of iron, but of copper, pasteboard, glass, &c., also yielded such sounds, came with some surprise on the world, and also pointed to a defect in the existing theory of the telephone and the production of sounds, which explained the telephonic utterance by the wavering attraction of the magnet on the slim diaphragm which was free to vibrate to and fro mechanically like a drum head. M. du Moncel, in considering these facts along with the discovery of Page, Wertheim, and others, that an iron core gave out sounds when an intermittent current was sent through a coil of wire surrounding it, conceived the theory that it was in the core that the secret of the articulation of the telephone resided, and that the diaphragm merely intensified the latter so as to raise it to the range of our hearing. According to him the articulation was due to molecular vibrations set up in the core of the receiving magnet by

the waves of current passing through the coil, and that the diaphragm acted as an armature and concentrated the effect. M. Navez, in a communication to the Royal Academy of Belgium, took up arms against M. du Moncel's theory, and after first doubting that the core could utter sounds at all, afterwards admitted that under exceptional conditions the sound of the voice could be given out by a receiving telephone without a diaphragm, but that it was so weak as to render it impossible to decide whether there was articulation or not. This admission of Colonel Navez, while leaving himself a loop-hole of escape, at the same time surrendered one of the outposts of his position to M. du Moncel, who only contended that the articulate sounds were there but not sufficiently loud to be heard. One charge more remained for M. du Moncel in order to claim the victory, and this was to magnify these inarticulate sounds in the core to the degree of audibility. This has been achieved for him by Professor Hughes with the help of the microphone. Professor Hughes' experiments are as follows :—

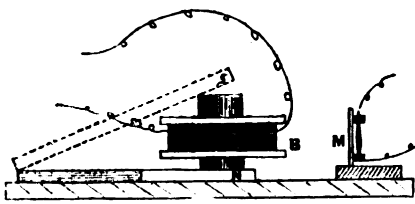


Fig. 1.

1. A bobbin of wire B (fig. 1), surrounding a soft iron core, is connected in circuit with a microphone and three cells. The ticking of a watch and other tones can be very feebly heard on listening to this simple electro-magnet. The sounds are very weak unaided; but on placing the electro-magnet on a wooden stand, to which is affixed an independent microphone circuit M, they are amplified by the latter, and can be distinctly heard in the microphone telephone. Here we have the microphone operating as a means of physical investigation. The vibrations of the core, due to the undulatory current traversing the coil, are brought into distinct audition through the medium of a microphone circuit.

2. These tones are in a striking manner intensified by bringing the pole of a bar magnet N into contact with one end of the core. *Articulation can now be distinguished* in the telephone of the auxiliary microphone, and the problem discussed by MM. Navez and Du Moncel may be regarded as fully solved, since the auxiliary microphone can only take up and intensify articulate vibrations first given out by the magnetic core of the bobbin, and communicated by the wood of the stand to the microphone. Here, then, we have the microphone rendering it possible for M. Navez to hear the voice proceeding from the core of a telephone without a diaphragm, and deciding that there is articulation.

3. When another bar magnet is placed with its opposite pole S in contact with the other end of the core (as shown by dotted lines in the figure), the effect is still further intensified. Here the core may be supposed to act as an armature concentrating the lines of magnetic force in the neighbourhood of the coil.

4. The two poles of a horseshoe magnet inserted together into the heart of the bobbin, instead of the magnetised core as figured, gave a strong effect also, notwithstanding the fact that one pole might be supposed beforehand to neutralise the other. This has also been observed by Mr. W. J. Millar of Glasgow. But the most distinct and loudest effect of all was obtained by placing a soft iron armature across the poles of this horseshoe magnet when inserted in the bobbin. Songs and articulation are well defined by this arrangement.

The striking increase in the loudness of the sounds given out by the core, in the first experiment, when the pole of the magnet was brought into contact with it, leads us to wonder whether the feeble sounds given out by the soft iron core itself were not due to some residual magnetism in it; and to doubt if a purely non-magnetic piece of iron would act at all. It is certain, at any rate, that an increase of magnetism in the core of a telephone intensifies its power of vibrating under the action of vocal currents.

II. *The microphone relaying itself.*—It is now well known that the "hammer and anvil" form of micro-

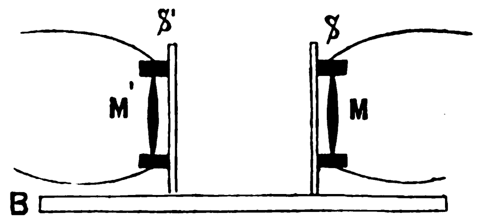


Fig. 2.

phone, when mounted upon a vibrating membrane or drum-head, is heard to act as a receiver of sounds, and to utter even articulate speech. To construct a successful one for this purpose, it is necessary that the hammer should weigh with a certain pressure on the anvil. Professor Hughes accounts for its action on the supposition that the alternate swelling and shrinking of the microphone contact, due to molecular causes as the vocal current passes, is unable to tilt up the hammer from the anvil because of its weight; and consequently the diaphragm beneath yields to the reaction and starts into vibration. Were it easier for the molecular forces to tilt the hammer than to bend the membrane, the vibrations would not become audible.

The microphone has, ere this, been successfully applied to relay telephone sounds; but Professor Hughes finds it to answer equally well as a relay for another microphone. Fig. 2 shows two microphones M M', mounted on upright boards S S', let into a base-board B. If M be connected in circuit with a transmitting microphone at a distance, and M' be connected in circuit with a battery and telephone, the sounds received by M from the distant microphone are relayed by M', and heard very distinctly in the telephone. For the telephone a receiving "hammer and anvil" microphone may be substituted, and then we have two purely microphonic circuits, one relaying the other, the sound, being transmitted by a distant pencil microphone relayed by a local pencil microphone, and heard proceeding from a local speaking microphone, no telephone being employed.

SOME ELECTRICAL EXPERIMENTS WITH CRYSTALLINE SELENIUM.

By ROBERT SABINE.

(*Concluded from page* 331.)

Action of Light and Heat the same.—The next experiment was to ascertain if the effect of light upon the surface is the same or the reverse of that of heat. Two short lengths of glass tube, fixed vertically, were stopped at the lower ends with corks, through which strips of platinum foil were passed. Across the tops of the vertical tubes (which were nearly filled with distilled water) two smaller horizontal glass tubes were fixed, over each of which a small saddle of white blotting-paper, intended to act as a conducting pad, was laid. The ends of the blotting-paper dipped into the water, and formed the connexion with a plate of crystalline selenium, whose ends rested on the paper on the horizontal tubes. The circuit was completed by inserting a galvanometer between the strips of platinum foil. The whole was mounted in a light tight case with a diaphragm, so that light could be excluded from or admitted to either horizontal tube at pleasure. When light was admitted to one tube, it had of course to reach the contact service of the selenium, after passing through the glass, the water, and the blotting-paper pad. It was, therefore, diffused and much weaker than had it fallen directly upon the face of the selenium as in the previous experiments. The indications were therefore less in amount, but nevertheless perfectly distinct.

Next, instead of admitting light to the selenium plate, both of the tubes were kept dark, and warm water was passed through either of the horizontal tubes, so that the wet blotting-paper pad upon it, and, therefore, the contact face of the selenium and water, was slightly warmed. A current was immediately observed. When this current had subsided, warm water was passed through the other tube, and the new deflection noted.

Now in both these tests it is evident that we are dealing, in respect of light and heat, with the *surface* of the selenium only, and have therefore eliminated any effects due to the molecular condition of the interior.

The following are the results :—

	End c.	End c'.	Deflection.
(1)	illuminated	dark	—200 div.
(2)	warmed	cold	—160 „
(3)	copper	zinc	—off scale
(4)	dark	illuminated	+ 50 div.
(5)	cold	warmed	+ 80 „

Therefore the effects of light and heat upon the surface of crystalline selenium are identical; and it was observed that this effect was to render the contact surface between crystalline selenium and water more electro negative.

Effect of Light on Conductivity.—The object of the following experiment was to determine whether the effect of light upon a plate of selenium when in a galvanic circuit, in increasing the current, is due to a photo-electromotive force in the same direction as the battery current, or to a decrement of resistance.

Let the resistance between the wires of the selenium plate in the dark and of the galvanometer be r, the electromotive force of the measuring battery be E, and the observed current c. On admitting light the current increases to c', and one of two things must have happened. Either (1) the increment of current is due to a decrement (x) of resistance, in which case

$$c = \frac{E}{r} \text{ has changed to } c' = \frac{E}{r - x},$$

$$x = E\,\frac{c' - c}{c\,c'}; \quad . \quad . \quad . \quad . \quad . \quad \text{(I.)}$$

or (2) the increment of current is due to a photo-electromotive force (y) in the selenium, in which case

$$c = \frac{E}{r} \text{ has changed to } c' = \frac{E + y}{r}$$

$$y = E\,\frac{c' - c}{c}. \quad . \quad . \quad . \quad . \quad . \quad \text{(II.)}$$

With a single measurement it is, of course, impossible to discriminate between the two cases; but by a known augmentation of battery and of resistance, it is easy to find which supposition affords the better agreement.

On increasing E to 2E, and inserting a known resistance (r_1) as nearly equal to r as possible, the resulting current, when the selenium was in the dark, was c_1; and it increased to c_2 when subjected to the same source of light as before. The either

$$c_1 = \frac{2E}{r + r_1} \text{ changes to } c_2 = \frac{2E}{r + r_1 - x},$$

$$x = 2E\,\frac{c_2 - c_1}{c_2 c_1}; \quad . \quad . \quad . \quad . \quad . \quad \text{(III.)}$$

or

$$c_1 \text{ changes to } c_2 = \frac{2E + y}{r + r_1}$$

$$y = 2E\,\frac{c_2 - c_1}{c_1}. \quad . \quad . \quad . \quad . \quad . \quad \text{(IV.)}$$

It is plain that, if the values of x calculated by (I.) and (III.) agree better than those of y calculated by (II.) and (IV.), the change must be due to resistance.

The battery consisted of twelve similar Daniell's cells of large surface. They were connected with a commutator, by which, with a single movement, they could be connected up either in series or six and six parallel. In this way, by using the same elements in each measurement, the effect of any slight accidental difference in their electromotive forces would be, to a great extent, neutralised. No difference could be observed by the discharge of an accumulator; and therefore it was assumed they were in every respect equal. The currents were measured by means of a reflecting galvanometer.

A selenium plate with six elements in the dark gave a current $c = 0{\cdot}498$ microweber. When the battery was doubled and the constant resistance r_1 added, the current observed was $c_1 = 0{\cdot}508$ microweber.

Diffused daylight admitted to the selenium, with the six double surface elements the current increased to $c = 0{\cdot}860$ microweber; with the twelve elements in series and resistance r_1 the current was $c_2 = 0{\cdot}643$ microweber.

Putting $E = 6.72$ volts, the values of x and y, calculated from the above data, are as follows:—

x		y	
I.	III.	II.	IV.
5·68 meg.	5·56 meg.	4·89 volts.	3·57 volts.

Similar measurements were made with two other plates, which gave the following results:—

x		y	
I.	III.	II.	IV.
6·39 meg.	6·43 meg.	5·76 volt.	3·86 volt.
5·52 „	53·0 „	0·75 „	0·53 „

It appears from the above, that the agreement between the calculated values representing the change, on the supposition that it is due to a decrement of resistance, is much greater than that between the values calculated on the supposition that it is due to an electro motive force set up in the selenium in the same direction as the battery current.

It is evident for these experiments that selenium is, from its peculiar nature, a very unsuitable material for constant resistances.

In the light it would of course be utterly useless for measuring-purposes, whilst in the dark the apparent resistance of its junctions with the conducting wires changes, not only with the direction of the current, but likewise with its strength, and to some extent also with its duration.—*Philosophical Magazine.*

THE QUADRUPLEX SYSTEM IN ENGLAND.

The quadruplex system of Messrs. Edison and Prescott was introduced into this country in September, 1877. It has, therefore, been on trial here for a year.

Fears were from the first entertained that our variable climate would greatly interfere with the working of the system, and, at the outset, a battery of 100 Fuller's Mercury-Bichromate Cells was used at each end of the wire; the supervisors being Mr. Gerritt Smith, the Assistant Electrician of the Western Union Company in London, and Mr. Hamilton, also of the electrical department of that company at the Liverpool end. When once fairly started, and in spite of variable and stormy autumnal weather, the operation proved eminently successful. Four distinct circuits were worked steadily on that wire for six or seven consecutive hours daily, and the number of ordinary messages per hour transmitted on the Quadruplex was at that time surprising. As many as 213 ordinary despatches were sent and received within the sixty minutes; a total said to exceed the highest number ever heretofore attained by American telegraphists in the native land of the system. This result appeared to astonish Messrs. G. Smith and Hamilton, who, not unnaturally, had believed the famed manipulation of their telegraphic compatriots to be entirely unapproachable.

The Quadruplex continued to behave satisfactorily after the return of the American electricians to the States, and may be said to have since then exceeded even the most sanguine expectations of its capabilities.

After having been in operation for some months to Liverpool, the apparatus was removed to Leeds, where a number of experiments have been made, and some improvements introduced that will materially enhance its value. The carrying power of the instrument, great as it is, can be increased about twenty-five per cent. by the Wheatstone Automatic Duplex System being used on the "double current" side of the apparatus. This has been effected between London and Leeds at a speed of fifty to sixty words per minute in each direction, without at all interfering with the ordinary duplex working on the "single current" side. Thus we may employ two independent and different systems, both duplexed, and transmitting between them a grand total of, say, 260 messages per hour, upon one wire two or three hundred miles long. By the introduction of this important English improvement, the capacity of the Quadruplex, as we have said, has been augmented, and, besides, it has demonstrated the economy in wires that will result from the extension of the system. For instance, if one "side" be used as a Duplex Wheatstone Automatic circuit from London to a large centre, such as Manchester, the other section may be worked independently as an ordinary Duplex circuit to, say, Carlisle, if a local line wire between Manchester and Carlisle be connected to the Quadruplex apparatus, which would act as a translator or repeater on the "single current" side. A London-Manchester length would thus be economised.

We believe that the Post Office have decided to extend the Quadruplex system immediately to several important telegraphic towns; in fact, the additional apparatus required for six or seven new sets are now nearly completed. Birmingham, Bristol, Southampton, Plymouth, and Jersey are spoken of as likely to receive the early benefit of these additional instruments.

RAPIEFF'S ELECTRIC LAMP.

In the last number of the Journal we gave a short description of M. Rapieff's new form of Electric Lamp. In actual practice the arrangement of the carbons is slightly different from that shown by the figure, one set of carbons being set vertically over the other set, and not horizontally as was indicated. Also M. Rapieff, instead of having the two sets of carbons lying in the same plane, prefers to have the plane of one set, to be at right angles to the other.

We are enabled, through the courtesy of M. Rapieff, to give some details of the method he adopts for effecting the subdivision of the light. Fig. A is the base of a lamp (inverted), showing the mechanism for enabling the object in view to be effected.

M is an electro-magnet, provided with an ordinary armature at the left hand poles; this armature is connected to the lever l_2. The upper of the right hand poles is hinged, and is connected to the lever l_1, which is itself connected to the upper set of carbons.

The armature connected to l_2 being light, is quickly attracted when the electro-magnet is excited, and when so attracted, in virtue of its being brought in close proximity to the left hand poles, it causes the magnetism of the right hand poles to be intensified; the upper (in the figure) of these poles is then drawn towards the lower one and being connected with the upper set of carbons, separates this set from the lower set, to the distance requisite to give the electric arc its necessary length. This dis-

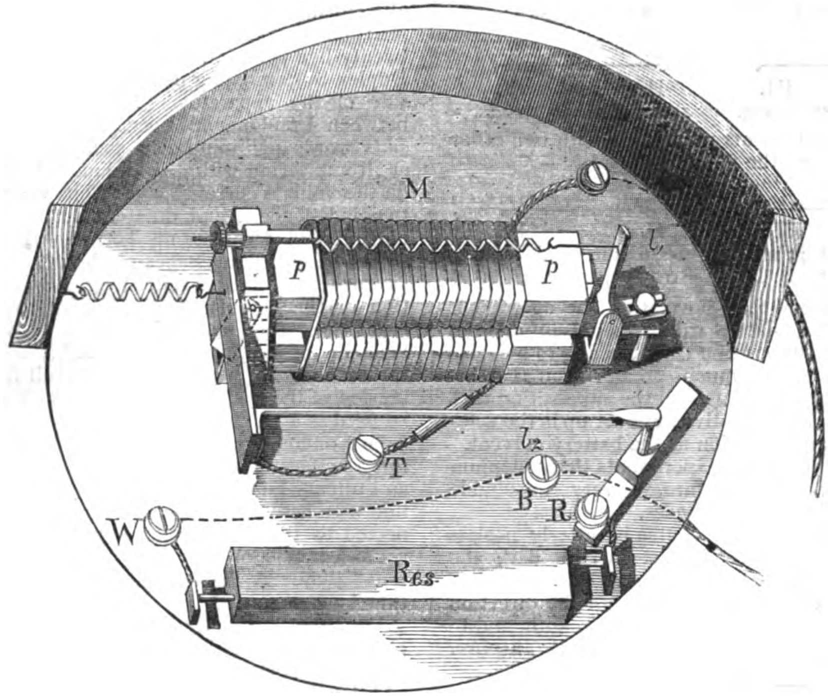


Fig. A.

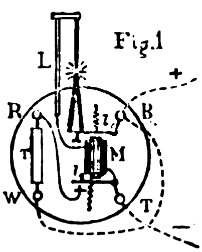


FIG. 2.

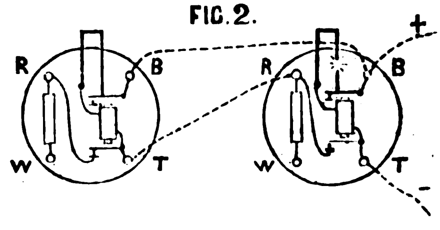
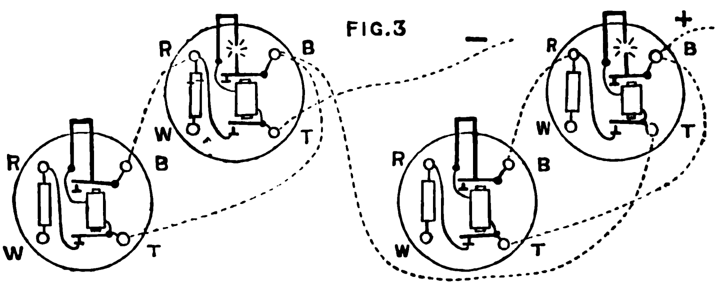


FIG. 3



tance can be adjusted to any width by means of set screws.

The lever l_2, when the armature attached to it is not attracted, makes contact with a contact point connected to terminal R. Between the latter terminal and terminal W, a resistance, rather higher than that of the electro-magnet (about 1 Siemens' unit), and made of pieces of carbon, is connected. The armature itself and the lever connected to it, are connected to terminal T, which terminal is also connected to one end of the wire of the electro-magnet. The further end of this wire is connected to the top set of carbons of the lamp, and finally, terminal B is connected to the bottom set of carbons.

Fig. 1 is an outline sketch, showing how a single lamp would be connected up for producing the light. In this sketch, l_2 is the armature and lever that break contact with terminal R; l_1 is the lever which separates the two sets of carbons. For the sake of distinctness in this and the following figures, this lever is represented as drawing down the lower set of carbons from the upper, though in practice, as was explained, it is the upper set of carbons that are moved.

The dotted lines represent the connecting wires necessary to work the lamp when it is used alone. Of these wires, those marked + and — are those leading from the machine.

The action of the apparatus is as follows:—

When the current is sent from the machine it enters, say, by terminal B, from thence goes to the lower set of carbons; and, as the two sets are normally in contact, goes to the upper set, through the electro-magnet, and back from terminal T to the machine. A portion of the current also traverses the resistance between terminals R and W.

Immediately the electro-magnet is excited, the armature connected to l_2 is attracted, and breaks the circuit of the resistance, so that the whole current passes between the carbons. The pole piece connected to the upper set of carbons is then attracted and separates the sets of carbons.

If there are other lamps connected in the circuit, and one of them should fail, from the carbons being consumed, or from any other cause, then the contact armature of the magnet of that lamp, by falling back, maintains the continuity of the circuit through the resistance.

Fig. 2 shows the connections when a reserve lamp is provided at each point where a light is being produced. Under ordinary conditions, that is, when the right-hand lamp is burning, the reserve lamp is cut out of circuit; should, however, the first-mentioned lamp fail, then the contact armature of its electro-magnet, by falling back, puts the reserve lamp in circuit.

Fig. 3 shows the arrangement of two lights with a reserve lamp to each.

THE ELECTRIC LIGHT.

Report by MR. G. H. STAYTON, C.E., to the Vestry of the Parish of Chelsea.

GENTLEMEN,—In accordance with your instructions, I have considered the question of the electric light in lieu of gas for street lighting, and have visited Paris to inspect the system now in operation in that city, with a view to reporting fully thereon.

I had interviews with M. Alphand, Director of Public Works (City Engineer); M. Jablochkoff, the inventor of the Electric Candle; M. Guichard, C.E., Agent to the General Electricity Company, and others, all of whom most readily afforded me valuable information upon the subject.

I learn that the Municipality of Paris have contracted with the above Company to light certain streets and places, notably the Avenue de l'Opéra and the Place de l'Opéra, which forms a magnificent new street nearly 900 yards in length and 30 yards wide. To effect this the Company have erected 46 lamp columns for the electric lights, at an average distance of 38 yards apart, on each side of the street, and have established three electric stations.

The lights consists of the "Jablochkoff Candle," utilised by means of the "Gramme" Dynamo-Electric Machine, by the aid of which 16 candles, (*i.e.*, lamps) are maintained, a steam engine being required to set and keep it in motion.

An electric machine is provided for every 16 lamps, the engine being placed in one instance in the front basement of an unfinished building, in another in a back room on the ground floor of similar premises, and in a third in the basement of the Opera House.

The electric apparatus is worked by a 16 h.-p. steam engine, with shaft and belts (1 h.-p. per lamp being thus absorbed), from which conducting wires for the current are laid in drain pipes under the footways, and carried to the lamps.

Upon a stand fixed on the top of the lamp-posts, at a height of about 16 feet, opaque globes (*Verre Opale*) about 18 inches diameter, are fixed, and they contain what is called the "Chandelier," which receives the candles.

An electric candle costs 7½d., and burns one hour and a half, but the chandeliers are made to receive in advance any given number of candles, and by means of a simple self-acting arrangement, when a candle is nearly consumed, the current is passed to a new candle, and the continuance of the light is assured without any visible interruption.

The intensity of a single electric light is stated to be equal to 700 wax candles, but the globes take off about one-third of the light. An ordinary street gas-light in London being equal to 12 or 15 candles, the superiority of the electric light may be easily understood.

The contract referred to may be termed an experimental one to a certain extent. The Company undertook to light the lamps for a period of six months, ending in November next, from dusk till shortly after midnight, and to provide the whole of the apparatus for 1f. 45c. (1s. 2½d.) per light per hour. Shortly before the electric light is extinguished, about one-third of the gas lamps are lighted and continue till sunrise, the former light being unnecessarily powerful, and too expensive to be maintained all night.

The number of lamps provided for lighting the Avenue and Place de l'Opéra by gas is exceptionally great; I should estimate that there are no less than 400 lights. The columns are placed at very short intervals, and have either three or five lamps thereon, consequently the average distance between each light if placed in a line, would be about five yards only.

Although such ample provision is made for gas,

the City Engineer says "that the cost of the Electric Light is four times that of gas, but a greater amount of light is obtained." On the other hand, in the lighting of the courtyard of the Louvre, it is asserted that a saving of 29 2-3 per cent. is effected by replacing 201 gas lamps by 16 electric lights, although 3½ times the amount of light is given.

It is scarcely necessary to remark that the leading thoroughfares in Paris are exceedingly well lighted. There are altogether 39,000 lamps in the city, the annual cost per lamp being £5 16s. Gas is supplied to the Municipality at *one-half* the price charged to private consumers.

The electric light has also been adopted for lighting the Place du Théâtre Françaisе, the Madeline, the Arc de Triomphe, the Orangerie des Tuilleries, the Magasins du Louvre, and about thirteen other places in Paris. It is also in operation in the principal places in Brussels, Madrid, and St. Petersburg.

COST OF ADOPTION.—The distance between the lamps in Chelsea being much greater than in Paris, and there being only one lamp upon each column, greatly increases the comparative cost of the systems. They are somewhat irregularly placed, but the distance apart on each side averages about: 55 yards in Sloane Street, 70 yards in King's Road, 35 yards in Lowndes Square, 35 yards in Cadogan Place, 28 yards on the Chelsea Embankment. In Piccadilly the distance is 30 yards, and in Cromwell Road, South Kensington, 27 yards.

To adopt the electric light for Sloane Street, which is 1,100 yards long and 20 yards wide, would necessitate two electric stations, each of which would require a 16 h.-p. steam engine, including shafts, belts, &c., a "Gramme" dynamo-electric machine, a shelter or other building for the machinery and apparatus, the alteration of 16 lamp columns, together with globes, stands, connectors, and the necessary conducting wires, the total expense of which would amount to the sum of £3,200.

The cost of lighting 32 electric candles, including coal, oil, waste, wages, &c., *per hour* would be 16s., and 3,250 hours consumption per annum would be required unless the lights were extinguished and gas substituted at midnight, as in Paris, in which case the annual cost would not be so great.

The present cost of a gas lamp in Chelsea burning 3,850 hours per annum is £3 6s. 7d., therefore the expense of the 40 lamps in Sloane Street is 8¼d. per hour.

To light the Chelsea Embankment, which is about 1,530 yards long, and has 109 gas lamps (including those on the river wall belonging to the Metropolitan Board of Works), would require a first outlay of £4,800 for 48 lights of 3,250 hours per annum, with an hourly cost of £1 4s. The present cost of the gas lamps is 2s. 1½d. per hour for 3,850 hours per annum.

To adopt the system in Sloane Square (where there are but 17 lamps) would scarcely be practicable, even if the motive power could be obtained from the pumping engine of the Metropolitan District Railway Station, or from the engine of any manufactory in the locality after the close of the ordinary day's work.

In connection with the foregoing estimates, it must be remembered that in the case of Sloane Street, the amount of light would be 31 times greater than at present, which might be considered an unnecessary expenditure; but the electric current is said to lose 40 per cent. of power beyond a radius of about 250 yards, consequently a "Station" for 16 lights has to be established at about every 500 yards which greatly increases the expense. Probably half the above number of electric lights would be found sufficient for effectually lighting Sloane Street, if the quality of the current could be fully maintained at double the distance, by which means alone the cost would be reduced 50 per cent.

GENERAL CONCLUSIONS.—I have arrived at the following conclusions, which may be thus stated briefly, viz.:—That the present arrangements for electric lighting are unsuitable for long distances (in this I am supported by the City Engineer of Paris), especially in London, where the lamps are so much farther apart than in Paris. The close proximity of the electric stations is a great drawback to the system, and their establishment in business streets would be a matter of considerable difficulty. These are the disadvantages of the system. The following are the advantages:—

About 1½ hours' daily consumption is saved in consequence of instantaneous lighting and extinguishing; the light is vastly superior to gas, and is not injurious; there is an absence of noxious smells both in the production and combustion; the heat in a room, so often unbearable in the case of gas, is scarcely felt; the most delicate colours are preserved; air is not consumed as in the case ot gas; there is no chance whatever of explosion, and, although the light is so powerful in the streets no accidents to horses have occurred.

If the cost of producing the "Gramme" machine (10,000f.) could be reduced, or a less expensive one be adopted; if hydraulic, or some other less expensive power, such as a petroleum engine, could be utilised as the motor in lieu of steam, or even a smaller amount of power than one-horse per lamp be rendered sufficient; if the distance between the electric stations could be greatly increased, the arrangements made capable of minute subdivision, and by some simple method the current could be branched off for household or other requirements, I feel sure that the public would gladly welcome such a change, and it would compete with gas under highly advantageous conditions.

The question is now largely occupying the attention of scientific men. At a recent meeting of the Institution of Civil Engineers, its discussion occupied three evenings. One speaker asserted "that one of the greatest advantages he saw in its introduction, was the possibility of its adding to the hygienic properties of buildings, as fresh air could be preserved, because the electric light consumes none, whereas gas consumes an enormous quantity." Another speaker (Sir William Thomson) having made a suggestion as to the construction of a copper tube for producing the electric light at a great distance, said "that he believed it would be possible to carry the electric energy to a distance of several hundred miles. The theory appeared to be that towns henceforth would be lighted by coal burned at the pit's mouth, for which purpose the dross could be used." On the other hand, another speaker asserted "that in all probability, *before* the electric light was perfected, the cost of manufacture of gas would have been so far reduced as to lift it even further beyond the reach of competition, and that

gas-makers' future promises in regard to improvements were as bright as those of the promoters of the electric light."

After a careful consideration of the whole question, I am of opinion that at present the electric light is *not* suitable for street lighting in the metropolis; that it *is* suitable and can be utilised with splendid effect in large squares and places, such as Trafalgar Square or Parliament Square; but although in each of these places at the present time the lamps are numerous, the cost would be greater than gas.

I am also of opinion that so soon as the modifications alluded to can be effected (particularly as to the electric current being carried to a much greater distance, thereby reducing the cost), the electric light will very soon supersede gas to a considerable extent, the attendant advantages being so great.

The following letter by Mr. J. Hollingshead has appeared in the *Globe*.

To the Editor of the GLOBE.

Seeing that Mr. G. H. Stayton's report on the electric light (I presume the "Jablochkoff Light") of Paris is going the round of the papers, I have referred its statements to Mr. Mayer and the French scientific gentlemen whom I brought over from Paris to establish and manage the electric light (called the Lontin Light) which I am burning every night in the Strand. Their answer, supported by elaborate details, is this:—"With machinery valued at £3,400 they are prepared to light an area of 1,540 yards long by 44 yards wide, with 36 electric lamps, exactly similar to those we are now using, having all the admitted advantages of the electric light, and an illuminating power equal to 2,000 of our existing street lamps, at a cost of 10s. 6d. per hour for consumption and superintendence. Thus, in place of 109 gas lamps, the public would get a lighting power nearly twenty times greater at a cost only five times greater than the present outlay. By reducing the number of lamps and making other alterations, the illuminating power and the cost could be reduced at the same time, until the difference between the cost of gas and electricity would be equalised, still leaving immense advantages on the side of electricity."

Yours, &c.,

JOHN HOLLINGSHEAD.

14, Pall Mall,
August 19th, 1878.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In Mr. Fahie's paper "On a New System of Duplex Telegraphy" (TELEGRAPHIC JOURNAL, April 15, 1877) there are some errors and mis-statements which I think you would like to be brought to your notice.

Mr. Fahie remarks that when

$$\frac{A}{B} = \frac{E}{L + X + E'}$$

and

$$\frac{A'}{B'} = \frac{E'}{L + Y + E}$$

R is not affected by working K, nor R' by working K'. Substituting the values of the letters in the example given by Mr. Fahie, we have—

$$E = E' = 100$$
$$L = 3050$$
$$X = Y = \frac{600 \times 1500}{600 + 1500}$$
$$= 428{\cdot}5$$

Hence
$$\frac{A}{B} = \frac{A'}{B'} = \frac{100}{3050 + 428{\cdot}5 + 100}$$
$$= \frac{100}{3578{\cdot}5}$$
$$= \frac{33{\cdot}3}{1192{\cdot}8}$$

But in the example $\frac{A}{B} = \frac{A'}{B'} = \frac{39}{1461}$.

Mr. Fahie says that when K is depressed "the greater part of the current from E goes to earth * * * and only the equivalent of 8·3 cells goes out to the line, or (say) $\frac{1}{4{\cdot}8}$ of the original strength, 40 cells."

The greater part of the current goes through the "up station" apparatus, and not to earth, and the remainder *through earth* to "down station" and line. The latter = 5·1 cells, not 8·3 cells

The current in the line is therefore = 45·1 cells, and the relay R' is actuated by 32·2 cells.

The following sentence is incorrect. "A signal, therefore, begins to be recorded, and its strength is the difference between 57 and 34·5 cells, or 22·5 cells." The strength of the signal = 34·5 (32·2) cells, not 22·5 cells, and the difference between it and the former signal = 22·5 (24·8) cells. It is obvious that the above sentence does not convey Mr. Fahie's meaning, as further on he observes: "a like effect is produced by working K', R' is unaffected, while the current in R is reduced by 22·5 cells."

In the sequel, Mr. Fahie tells us "according, then, to the positions of the keys the line is traversed by currents of the following strengths—80 cells when both levers are at rest, 48·3 cells when one up and the other down, and 16·6 cells when both down."

What we particularly want to know is the effect which the currents produce on the relays and why duplex work is possible. This would have been more clear if Mr. Fahie had shown that—

(1) When both keys are at rest, current through each relay = 57 cells.

(2) When one key is depressed, current through relay of that station = 53·5 cells; current through relay of other station = 32·2 cells.

(3) When both keys are depressed, current through each relay = 28·5 cells.

The above are the results of my calculations with which I need not trouble you.

Mr. Fahie gives a formula for finding the proper value of the shunts.

$$A + B = \sqrt{RW}$$
$$= \sqrt{600\,(3050 + 600 + 100)}$$
$$A + B = \sqrt{600 \times 3750}$$
$$= \sqrt{2{,}250{,}000}$$
$$= 1500$$

which is correct.

On page 87, however, there is a misprint—

$$B = \frac{L + X + E}{L + X + E' - E}\sqrt{RW}$$

should be

$$B = \frac{L + X + E'}{L + X + E' + E}\sqrt{RW}$$

I should be pleased to get an explanation of the discrepancy pointed out at first; viz, why $\frac{A}{B} = \frac{33 \cdot 3}{1192 \cdot 8}$ instead of $\frac{39}{1461}$.

I am, Sir,
Yours truly,
H. A. W. FANSHAWE.

Indian Gov. Telegraphs.

ELECTRICITY IS LIGHT.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—Can it be possible that what has all along been called electricity is nothing else but light, and that it is light and nothing but light that is, at the present moment, crossing and recrossing the innumerable wires from one world's end to the other? Why should light, in a condensed form, not travel better in silver, or iron, or copper, than it does in the firmament? Why should it not travel worse in gutta-percha or glass? What is lightning? Is it not a discharge of condensed light? Why should the earth not attract light to its centre the same as it does an apple falling from a tree? If it does do so, would this not account for the perpetual furnace that is blazing below our feet? Can light not be positive and negative? Is it not indestructible? If it be indestructible would not a discharge take place when that great condenser, the earth, is too full of it? Is it not reasonable to suppose that this discharge would be enormous, and that it would take place in the Poles? Is the "Aurora Borealis" not the positive discharge? Is the "Aurora Australis" not the negative? Would such a discharge not enter and disturb all light conducting wires within a radius of many a mile? Does this not happen? What is a battery? Is it not an arrangement for accumulating light? What is a microphone? Is it not an arrangement for varying the intensity of this light during its passage through a light conducting substance? Will not all this unravel the mystery of the loadstone and many other mysteries?

I hope your readers will not make light of this subject; but if they can throw any more on it, or, if they can completely extinguish it, they will oblige me by doing so through the medium of your esteemed JOURNAL.

F. VON DER PFORDTEN.
Superintendent,
The Eastern Extension Telegraph Co.
Foreign Memb. Soc. Tele. Engineers.

Batavia, Java.
24th July, 1878.

H. A. W. F.—The telegraphic arrangements in Cyprus are, we believe, at present in charge of a detachment of the Royal Engineers, but for further information on the subject we would recommend you to apply to the Secretary of State for the War Department.

Notes.

THE TELEPHONE.—M. Righi, a professor of Boulogne, has constructed a transmitting telephone, which appears to combine those of Edison and Gray. In Gray's telephone, it will be remembered, a needle sticking out rom a diaphragm probes into a liquid conductor under he vibrations of the voice, and regulates the current in this way. In Righi's form the liquid is replaced by a mixture of plumbago and silver powder, and a small brass disc is substituted for the needle. The current from two Bunsen cells is employed; the receiver is a Bell telephone with parchment membrane. With this combination the sounds can be heard at a distance of several metres from the receiver.

THE first use of the telephone under water in this country (America) has been recently made in connection with submarine examinations in Boston Harbour. The character of these examinations was such that it would have been impracticable to undertake them without its aid, as almost constant communication was necessary between the diver and his assistant in the boat. The telephone used under water has a metallic case so modified in form as to occupy but little space, and is attached by screws to the inside of the diver's helmet in such a position that either the ear or the mouth can be applied to it. In the boat a single telephone of the ordinary form is used. The insulated copper wire connecting the two telephones passes through the air pump box. Between the pump and the diver's helmet it is wound spirally round the air hose, the wire and hose being then tightly wound around with canvas, for protection against injury. At first two connecting wires were used, the second not necessarily insulated, but it has since been found better to substitute for the second wire a shorter wire connecting the upper telephone with a copper plate fastened under the boat.—*Engineering News*, U.S.

THE TELEPHONE AND TORPEDOES.—A very ingenious and interesting application of the electric telephone to torpedoes has recently been effected by Captain C. A. McEvoy, U.S., of 18, Adam Street, Adelphi. This gentleman, who is well known as an authority on torpedoes, has utilised Professor Bell's articulating telephone for the purpose of testing buoyant contact torpedoes, large numbers of which have been provided by nearly all maritime governments for the defence of their rivers and harbours in the event of war. Torpedoes of this class have a certain amount of buoyancy, and are held in their places under the surface of the water by means of mooring lines and anchors. They are connected with the shore by electric cables, through which they are tested or exploded from the batteries on land. They may also be exploded electrically when struck by passing vessels, which result is accomplished by means of a delicate piece of mechanism known as a circuit-closer, which, with the fuse and the explosive charge, is contained within the torpedo. After the torpedoes have been moored, it is necessary that they should be constantly tested, in order to ascertain their condition, to know—that is, that they are still afloat and their charge not drowned. The testing is performed by sending a current of electricity through the torpedo and fuse; but in order that the fuse may not be fired, and the charge exploded during testing, a very weak current only is employed in connection with a

sensitive galvanometer. The result of this testing is that the delicate indications received are frequently of a most unreliable character, and difficult to determine from those of occasional leakage in cables and their connections. Captain McEvoy, therefore, substitutes testing by sound for electric testing, or at least to supplement the latter by the former. To do this he places in each submerged torpedo an ordinary Bell telephone, so arranged that the vibrating disc lies in a horizontal plane. On this disc he arranges a number of small moveable weights which are enclosed. These little weights, with every motion of the torpedo, cause a vibration of the disc, and a peculiar noise is heard in the receiving telephone on shore. By this means each torpedo tells its own tale, as regards its condition, to the operator on land. Should any of the torpedoes from any cause be sunk, or should their charge be drowned, they would be at rest on the bottom, or earth would be made: in either case no sound would be heard, and this would afford unmistakable evidence of the unsatisfactory condition of such torpedoes as were silent. The telephones are connected to the ordinary wires or cables of the torpedoes, and they in no way interfere with testing by the electrical method. One telephone on the shore will suffice for testing any number of moored torpedoes. From what we have stated, it will be seen that Captain McEvoy has started an idea which may probably form the basis of a far more simple and reliable system of defensive torpedoes than we now have, and which may, moreover, be applied to other useful purposes. Captain McEvoy has experimented with Professor Hughes's microphone in connection with the present subject, but he does not find it so well adapted for his purpose as the telephone. This arises from the extreme sensitiveness of the microphone and the delicacy of its adjustment, a feature which renders it more liable to error when placed in positions where it cannot be got at for occasional readjustment. The telephone would seem to be the instrument for the work, and we congratulate Captain McEvoy on this happy application.—*Engineering.*

DR. HENRY MORTON, of the Steven's Institute of Technology, Hoboken, New Jersey, U. S., obtains very loud musical sounds by means of a simple Reiss telephone, in circuit with a horse-shoe Bell telephone, the diaphragm of the latter consisting of an oblong plate of soft iron glued to the bridge of a guitar, from which the strings have been removed. This armature is attracted by the vibratory current and the guitar reinforces the sound so that its singing can be clearly heard in a hall containing 3,000 persons.

MR. F. G. LLOYD, Highgate, writes to the *English Mechanic* for August 9th, describing several experiments by which he has been able to receive articulate sounds, both speaking and singing, on a telephone without any diaphragm, that is, on a simple electro-magnet. The transmitter was a microphone, and four Leclanché cells were in circuit. The same electro-magnetic arrangement also proved a feeble transmitter, a Bell telephone being used as receiver. This curious fact supports the theory of the telephone espoused by M. du Moncel.

THE MICROPHONE.—A naturalist, Mr. Bairstow, suggests the use of the microphone for the investigation of the stridulation of insects.

THE London Stereoscopic Company are making an extremely useful practical microphone; not a toy, but a powerful speaking telephone.

MR. CHANDLER ROBERTS, F.R.S., has made an interesting application of the microphone to the phenomenon of the diffusion of gases. By its means he is enabled to hear the pattering of the atom shower of gases diffusing through a porous septum. The noise is said, without exaggeration, to resemble the rush of a tropical rain-squall through a forest. It must be very gratifying to Professor Tyndall to know that he may yet listen to the clash of atoms and the *melée* of molecules.

THE PHONOGRAPH.—In his study of the phonograph record, Mr. Edison finds that he can recognize certain known sounds from their indentations when these sounds are made by the same person, not unless. In spite of the irregularity existing in the points of the same sounds uttered by different persons, or by the same persons under different conditions, he claims that the record of any one sound can be distinguished from any other sound. Between the records of vowel sounds very little difference could be detected. For some vowels the indentations were deeper at one end than at the other; giving to the characters the shape of eggs, pears, and Indian clubs. This is usually the case with the vowel E. The deepest indentations are made by consonant sounds—on account of the explosive force with which they are uttered; P, especially being distinguished by the pit which begins the imprint.

AN American paper informs us that the phonograph has now been so highly perfected and improved that one can smell whiskey when it speaks.

ALL the materials for constructing a cheap phonograph which will talk, whistle, and sing, are being sold in America for a dollar and a-half.

THE French papers state that Mr. Edison will not receive any award at the Paris Exhibition for the phonograph. This is because the jury of the section on Instruments of Precision declared it not to be an instrument of precision, but a toy; and the section on Telegraph Apparatus judged it to be of no use in telegraphy, and refused to examine it. Our neighbours, in their boasted passion for method, very frequently destroy all method. The phonograph is properly an acoustical instrument of precision—the researches of Messrs. Jenkin and Ewing on articulate sounds put this

beyond question; and it is also a telegraphic instrument, inasmuch as it can, and will, be used for audible signalling.

The Vestry of St. James's have intimated that the Lane Fox system of lighting the street lamps by electricity recently tried at Pall Mall has not succeeded, and that the apparatus will be removed.

The cable and caoutchouc factory of M. Mennier, Rue de Grenelle, Paris; the workshops of MM. Sauter and Lemonnier, Rue Suffren, are lit electrically eve ry night. At the spinning mill of Champ du Pin (Epinal). four electric lamps have been employed to light a flat of 1,314 square metres. Each lamp, with its clouded globe, yields a light equal to 80 carcel lamps with an expenditure of two horse-power. The workmen prefer it to gas.

The Town Council of Ayr has resolved to carry out a series of experiments in lighting the town with electricity.

On another page we print the report of Mr. G. H. Stayton, the surveyor of the Chelsea Vestry, on the new systems of electric lighting in Paris, and also a communication from Mr. Hollingshead on behalf of the Harding Electric Light Company, 14, Pall Mall, formed to work Lontin's system, which is to be seen nightly in front of the Gaiety Theatre, Strand.

A further amalgamation of the London Gas Companies is reported. There are now six companies in London. Of these, the Phœnix, which supplies half the gas consumed in South London, has agreed to amalgamate with the Chartered, which furnishes two-thirds of the supply for the whole Metropolis. Proposals for the union of the Chartered with the Surrey Consumers Company, and with the South Metropolitan Company have also been made. The sanction of the Board of Trade and the approval of the shareholders are required for these amalgamations, but no application to Parliament is necessary.

The Metropolitan Board of Works has instructed its scientific staff to consider the whole question of electric *versus* gas lighting.

The gas companies begin to show their dread of the rival light by taking it up themselves. The Chartered Gas Company are experimenting with it on their premises, and going into the question of cost and manipulation. This is prudent policy on their part; but it is to be hoped for the public benefit that they will not be able to effect a monopoly of the new lighting power.

We understand that Dr. Ager has in the press a second edition of his Telegram Code, to appear shortly. The work has been greatly enlarged so as to afford facilities for sending about 50,000 telegrams. The Code words have been revised by a competent telegraphist, connected with a leading telegraph company.

General Science Columns.

We are informed that a course of six lectures on Meteorology will be given under the auspices of the Council of the Meteorological Society, commencing in October next. The subjects of the lectures will be, "The Nature and Physical Properties of the Atmosphere;" "Air Temperature; its Distribution and Range;" Atmospheric Pressure, Wind and Storms;" "Clouds and Weather Signs;" Rain, Hail, and Electricity;" and "The Nature, Methods, and General Objects of Meteorology." It is intended that these lectures shall give a concise account of the present state of knowledge on the above subjects. The lectures will be open to the public, admission being by ticket, to be obtained at the office of the society, 30, Great George Street, Westminster, S.W. Further particulars giving full information as to the time, place, &c., will be duly announced.

The Yellowstone Park.—Protect the Yellowstone Park by all means possible and practicable. It is a creation that no vandal should be suffered to gaze upon. Secretary Schurz's request for 15,000 dollars to improve and protect it should be granted without a dissenting voice. The report of the superintendent of the park shows the absolute necessity for a live guardian—one who can shoot. The superintendent says that the Act of March 18th, 1878, set aside and dedicated the Yellowstone National Park for the benefit and enjoyment of the people, and provided formally against trespassers, and for the preservation from injury and spoilation of all timber, mineral deposits, and natural curiosities and wonders within it, and their retention in their natural condition; also against the destruction of fish and game and for the construction of roads and bridges therein. No appropriation has as yet been made to execute this legislation within my personal knowledge, which is confirmed by official publications and those of travellers. Valuable forests of pine and cedar timber have been prostrated and travel impeded by the careless use of fire. Bison, elk, antelope, big-horn sheep, and other beautiful and valuable animals have been slaughtered by the thousands merely for their tongues and pelts. Great masses of ancient timber, fossils, geysers, cones, and beautifully scalloped pool borders which made the region valuable have been broken up to obtain transportable specimens, which have been made articles of fraudulent commerce. The preservation of these animals and wonders, and the construction of roads, bridges, &c., are necessary to carry out the Act. The opening of the great Yellowstone route by steamboats, and the approach of several railroad routes in rapid construction towards it, show the immediate need of practical means, both to preserve the park from irreparable damage, and to make the beauties enjoyable.—*Ex.*

Coating Iron with Rust.—A new process for coating iron with a protecting layer of oxide is announced from America. Mr. G. Bower places the articles to be coated in a chamber of fire-clay provided with two pipes—one for the admission and the other for the escape of air. Both pipes having been closed, the heat is raised to a temperature of about 1,700 degrees Fah. At the end of each hour the pipes are opened so that fresh air may enter and drive out the deoxidised air. This process is continued until a film of gray, or magnetic oxide, is formed on the articles.

Plating Iron with Platinum.—M. Dode, of Paris, has patented a process for coating iron with platinum. The iron first receives a coating of lead and copper, and then the platinum is applied. The first coating is prepared by mixing 22 parts of borate of lead and 4½ parts of cupric oxide in oil of turpentine, and is applied by means of a fine brush. The platinum coating is prepared by converting 10 parts of platinum into chloride, which is mixed with 5 parts of ether, and permitted to evaporate in the air. The residuum is mixed with a viscid combination of 20 parts borate of lead, 11 parts red lead, and some oil of lavender, and 50 parts of amylic alcohol added to the whole. In this mixture the object to be platinised is dipped, allowed to dry in the air, and then heated to a moderate temperature.—*Journal of Applied Science.*

A Submerged Torpedo Boat.—The Rev. G. W. Garrett, Manchester, has invented a torpedo-boat which is capable of sailing under water and fixing torpedoes to a ship's hull. It can be propelled by the men on board, by compressed air, or other motive power, and is lighted by electricity. Electric beams can also be directed in any direction under water. The supply of air taken in for the use of the men is purified by a very ingenious process, which is also applicable to diving bells, and enables the men to remain several hours submerged. A successful trial of this boat was made recently at the Birkenhead docks. While on this subject we may mention that a new and very devastating torpedo has been invented by Mr. Ericcson.

City Notes.

Old Broad Street, August 29th, 1878.

The report of the Submarine Telegraph Company shows that the receipts for the six months ending 30th June last, amounted to £59,016, or a decrease of £886 compared with the corresponding period of 1877. The net profits are stated to be £38,875, and out of this it was proposed to declare a dividend at the rate of 17 per cent. per annum. The balance brought in from the last account was £359, and the balance now carried forward is £327. The half-yearly meeting of the proprietors was held on the 20th inst. at the City Terminus Hotel, Sir James Carmichael, Bart., in the chair. The report having been taken as read, the Chairman said: "The Directors had found it necessary to insert a new length of about five miles in the cable between Jersey and France, which cost £1,123, and this sum had been charged to the cost of repairs in cables." He then moved the adoption of the report, and attributed the decrease in the receipts to the depressed state of trade, and was glad to say that "since the half-year had terminated their business had returned to its former favourable state. The reserve fund now amounted to £64,000. He was pleased to see that in addition to the invention of the telephone, a new invention had been made by which taste could be conveyed along telegraphic wires, and the company would be very happy to lease one of their wires to the Lord Mayor and the Corporation of the City, by means of which they would be enabled to entertain municipal authorities of foreign countries at sumptuous banquets." (Laughter.) Mr. James M. Wood, a shareholder, having formally seconded the motion, a short discussion ensued, and, in reply, to questions and observations, the Chairman said they estimated the "life" of their steamer at about fourteen years. It would always be worth its money. The Secretary said they had already £3,622 to the credit of the steamer fund, and the French Company had another £1,200. This made together £4,822, and the steamer cost only £15,000. The Chairman further observed that the sum of £4,822 was independent of the boilers, for which they had a separate fund. They were, therefore, making provision sufficient for the steamer. He then put the motion, which was carried unanimously. The Chairman then moved the declaration of dividend for the half year at the rate of 17 per cent. per annum. Alderman Sir Thomas Dakin seconded the motion, which was carried unanimously. The Hon. Ashley Ponsonby, a Director, then moved the re-election, as members of the Board, of Sir James Carmichael, Bart., and Sir Julian Goldsmid, Bart., M.P. The motion was seconded and carried unanimously, the retiring auditors having also been reappointed.

The ordinary general meeting of the shareholders in the Mediterranean Extension Telegraph Company was held on the 21st inst. at the City Terminus Hotel, Cannon Street. Sir James Carmichael, Bart., was in the chair.—The report stated that the half year showed a sensible improvement over the working of the previous one, and but for the troubled condition of Greece, which had interfered with the Corfu traffic, would have exhibited a still better result. There had been a suspension of work for some time past through the Alga-Grande cable. The Board recommended payment of the usual 8 per cent. dividend on the preference shares, less income tax, and of 3 per cent. on the ordinary stock, free of income tax, leaving £471 13s. 4d. to be carried to the reserve fund.—The Chairman in moving the adoption of the report and accounts, observed that he did not know that he had many comments to make on the report. As to the cable which was injured, it was the old cable; the injured part was about seventeen or eighteen miles from the Sicilian coast. There was no difficulty in repairing it, but the steamer belonging to the Eastern Company had had a good deal of work to do for the Government, and they had been unable to allow the use of a steamer. Meantime the work was done by the other cable, so that the injury only led to delay. When they could get a steamer probably it would only take a short time to do the work of repair. Considering how long the cable had been down it was not in a very bad condition. As to the reserve fund, it had been the wish of the proprietors that they should take counsel's opinion as to that fund. The whole of the case was laid before Mr. Kay, Q.C., of the Chancery Bar, with reference to the conflicting claims of the ordinary and preference shareholders, and the effect of the opinion of the learned gentleman was that the reserve fund belonged to both classes of shareholders, they being equally interested. This was a fund that they drew upon from time to

time, and which benefited both classes equally.—Mr. Field seconded the adoption of the report. He thought some steps should be taken to amalgamate with some more influential and powerful company.—Mr. Robinson made inquiry as to the Cyprus cable.—The Chairman said he should wish to charge all he could to the revenue for the half-year, keeping the reserve fund for other purposes. He could not tell what the expense of repairing the cable would be until the engineer had overhauled it and reported. He thought that now that we were extending our Empire in the East, the Company had a strong claim on the Government and as soon as he heard that Cyprus was to come under British protection he put himself in communication with the Government. At present he did not know what they had decided about the line from Alexandria to Cyprus. He had heard rumours, but he did not think that anything definite was settled. As regarded amalgamation, he had put himself in communication with another company, but he did not know what the result would be. The report and accounts were adopted, and the dividends declared.—A vote of thanks to the chairman closed the proceedings.

The ordinary general meeting of shareholders of the Cuba Submarine Telegraph Company was held on the 19th inst. at the offices of the Company, 61, Old Broad Street, Mr. Thomas Hughes, Q.C., in the chair. The particulars of the report presented to the meeting we published in our last issue. The Chairman said that shareholders would naturally be desirous to hear something about the repairs to their cable which had been executed during the past half-year. The cable was laid in April, 1870, and in October, 1873, an interruption took place which lasted for six months, and involved a loss of £20,000. The interruption which had recently occurred was practically as serious as the the first, but, owing to the policy which had been followed by the board, the cable had been cut and landed at Cienfuegos, but, owing to its having been duplicated all the way to Santiago, no loss had resulted from diminution of traffic. The total cost had been £12,600, and the interruption lasted only 45 days instead of six months, as on the previous occasion. To meet these contingencies, the directors had determined to lay by a sum annually, as it was impossible to tell when they might occur. This had been the policy of the directors from the first, and their object in now recommending a rather smaller dividend than usual was simply to enable them to add to the reserve fund. In his opinion they ought to be in such a position as to be able to lay down a new cable throughout, should that ever be necessary, and until that were arrived at he should not consider their affairs to be in a satisfactory condition. He had received letters from several large shareholders expressing approval of the policy of the board, and their readiness to accept the temporary diminution of dividend proposed. One gentleman stated that he trusted the dividend would not be increased beyond 6 per cent. until the reserve fund had been increased sufficiently to meet all contingencies. Directors had always encouraged communications from shareholders, and were pleased to hear their views, as it showed that they took an interest in the affairs of the company, and so strengthened the hands of the directors. The number of shareholders had increased from 100 at starting to 400 at the present time, and this proved that increasing confidence existed on the part of the public. Comparing the balance-sheet of the present half-year with that of 1877, he found that the traffic receipts had fallen from £19,500 to £18,300. There was no reason for supposing that was a sign of permanent depreciation. Most probably the traffic would speedily recover itself. The deficiency was to be accounted for by the change of tariff which the West India Company had felt themselves bound to make upon their line. This had not, in any sensible manner, deteriorated the number of messages, but it had had the effect of limiting the number of words in the messages, and the consequence was a considerable reduction in the traffic receipts. Mr. Keith, a most competent officer, had expressed himself satisfied with the condition of the cables generally, and he had just completed a very important work for their neighbours, the International Ocean Company. Their cable had been interrupted, and, having seen how successfully the repairs of the Cuba Company had been executed at the beginning of the year, they applied to Mr. Keith to take the control of their repairs. The directors were very pleased to accede to this, because it gave their officer greater experience in a very difficult part of the ocean for laying cables: for no more troublesome place existed for that purpose than the strait between Havana and the mainland. Moreover, it strengthened the good understanding between the two companies, and enabled the International Ocean Company to test and to prove the value of their repairing ship. Mr. Keith had now had experience of the ships of both their northern and southern neighbours, so that he might be expected to be able to meet any new difficulty which might possibly occur. Directors proposed to pay only six per cent. this half-year, and he trusted that shareholders would see the wisdom of the proposition. He moved that the report be received and adopted. This having been seconded, was, after some slight discussion, carried unanimously, and the meeting terminated in the usual manner.

The directors of the Indo-European Telegraph Company, Limited, have declared an interim dividend for the half-year ending June 30th last, at the rate of 5 per cent. per annum, free of income tax, payable on and after October 1st next. At the extraordinary general meeting of this company, mentioned in our issue of the 15th inst., the business was of a formal character, and the resolutions authorising the agreement to be carried out were adopted.

The following are the late quotations of telegraphs:—Anglo-American, Limited, 60¾-61¼; Ditto, Preferred, 90½-91½; Ditto, Deferred, 33¾-34¼; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6¾-7; Cuba, Limited, 9½-10; Cuba, Limited, 10 per cent. Preference, 16¾-17¼; Direct Spanish, Limited, 1-1½; Direct Spanish, 10 per cent. Preference, 9½-10; Direct United States Cable, Limited, 1877, 13-13¼; Eastern, Limited, 7¼-7¾; Eastern, 6 per cent. Debentures repayable October 1883, 105-108; Eastern 5 per cent. Debentures repayable August, 1887, 99-101; Eastern 6 per cent. Preference, 11⅜-11⅝; Eastern Extension, Australasian and China, Limited, 7⅜-7⅝; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109 xd.; German Union Telegraph and Trust, 8-8½; Globe Telegraph and Trust, Limited, 5¼-5½; Globe 6 per cent. Preference, 10⅞-11⅛; Great Northern, 8⅜-8⅝; Indo-European, Limited, 20½-21½; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 9¾-10¼; Reuter's Limited, 10-11; Submarine, 228-233; Submarine Scrip, 2⅛-2⅜; West India and Panama, Limited, 2-2¼; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited; 4¼-4¾; Ditto, 6 per cent. Debentures "A," 93-96, Ditto, ditto, ditto, "B," 91-93; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds, 114-118; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 30½-31; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅝-2⅞; India-Rubber and Gutta-Percha and Telegraph Works, Limited, 31-32.

THE TELEGRAPHIC JOURNAL.
VOL. VI.—No. 135.

TELEGRAPHIC INVENTION AND THE POST OFFICE.

THERE has been a decided tendency of late in certain scientific circles to depreciate the expositor and to glorify the discoverer. We do not think with that tongue-tied band, who, feeling that they lack the graces of diction and the power of verbal illustration, and envious of the reputation which these faculties procure their fortunate possessors, seize every opportunity of shearing the latter of their bright but ephemeral fame. We would honour the successful lecturer as well as the inventor, the preacher as well as the apostle, the bard as well as the warrior. We would give him due credit for his gift, his study, and his art; although at the same time we would know how to rank the endowments of the originator as the higher and more valuable of the two. Both kinds of ability come, however, by nature, and both are necessary. In every well-appointed profession there is a place for the speaker and the writer; and so is there in elegraphy. Mr. W. H. Preece would, we are sure, be named by a large majority as the mouthpiece of the electrical body in England. It is easy to decry expositors' powers, but it is very difficult to rival them, and we know of no member of the profession who rivals those of Mr. Preece. Our writer has not yet appeared, but in the meantime, let us not undervalue our spokesman.

The recent utterances of Mr. Preece at the Dublin meeting of the British Association* induce us to believe that he is not quite so happy with the pen as he is with the voice. The paper which he read before the Mechanical Section of that body is neither lucid in arrangement nor felicitous in style. Short and brilliant periods are little suited to express all the shades of accuracy, and scientific truth is ill at ease in the frippery of an epigram. Mr. Preece, we think, would have done his own arguments as well as those of his opponents, more justice had he allowed himself greater scope in the lineal dimensions of his sentences. We are not aware that any one but Mr. Preece himself has unqualifiedly said that invention in telegraphy had entirely left the shores of England and flown to America; some high authorities have held that it languishes here, and because of the Postal Telegraph monopoly. Mr. Preece does not believe that it even languishes; on the contrary his paper was read to show that improvement in telegraphy has never before been more active in England than since the Government has managed the business.

Mr. Preece's paper is more a vindication of the energy and ability of the electrical department of the Government service than a disproof of the allegation that the latter checks invention. He is arraigned at the bar of professional opinion, and he feels called upon to clear the charges which have been made. It is a justification of himself and his colleagues—a loud blast of the ego-trumpet—he has given us; not a convincing disproof of the point in dispute, and which, whatever Mr. Preece may think to the contrary is seriously believed by the majority of English and also American telegraphic inventors, namely, that the Postal Telegraph monopoly, as at present organised, has a baneful influence on inventions.

Mr. Preece mentions a great many novelties which have been introduced into the service since the Government took it over, and points out the further development of lines which has taken place. Neither the development of lines, nor the advances in submarine telegraphy, have to do with the question. Cables are in the hands of private companies, and mileage of wires only speaks for the enterprise of the Government officials. As regards the novelties adopted, it is too evident that the most valuable of these, with the exception of one, the Wheatstone Automatic, are foreign inventions. Mr. Preece states that the sounder is supplanting the Morse, the type-printer, and the needle instrument, on our lines; but where does the sounder come from?—America. Siemen's direct ink writer, is it not from Germany? Leclanché's battery, and Clamond's thermo-pile, are they not from France? While Bain's chemical recorder, Stearn's duplex, Edison's quadruplex, Gray's multiplex—have they not come from America also? It is no doubt true, as Mr. Preece says, that these systems have only been revived and perfected in America; but why is it that they have not been revived in England? Why have they lain neglected here, until they were resuscitated for us by the more vigorous invention across the Atlantic? Why has it been left for Mr. Elisha Gray, of Chicago, to realise in practice the harmonic telegraph patented by Varley, in 1870, in England? It is true that some minor improvements and inventions have been made by English inventors of late, especially by those in some way or other connected with the Post Office; but, excepting Wheatstone's Automatic, we have no first-rate novelty to show. For the sounder, the duplex, quadruplex, and telephone received from America, what electric apparatus have we given her?—"on some lines they have introduced automatic tele-

* See TELEGRAPHIC JOURNAL, September 1st, 1878.

graphy, as modified by Messrs. Little and Edison," and they are trying our batteries—that is all. Mr. Preece has only disparagement for the principal apparatus in use in France; and evidently rates the much lauded Wheatstone Automatic as far superior to those in point of expediency; but for all that, nearly 100 words per minute can be printed off by the Baudot-Hughes apparatus, and this without the expense of highly skilled operators, and copying clerks. When it is remembered that this system can be duplexed, if need be, it will perhaps be admitted that the French are little behind us, if not ahead, in fast-speed telegraphy.

We have no intention of criticising at length the table of patent statistics which Mr. Preece presents us with, although we have more than a suspicion that some American patents have been inadvertently included in his numbers. We shall just point out, however, that column 3, which gives the numbers of patents referring to the manufacture of telegraph material, during the last sixteen years, shows a notable falling off during the last six; and we shall supplement Mr. Preece's table with the additional information that during the eight years preceding 1862 (the first period given by him) the average of patents yearly taken out was about 70 as compared with 48 during the following eight years, and 52 during the last eight. From 1835 to 1842 only six telegraphic patents were taken out; from 1842 to 1852 fifty were taken out; in 1852 twelve were taken out; in 1854, thirty-three; in 1857, fifty; in 1858 (the year of the first Atlantic), a hundred and eight; from 1858 to 1862, over a hundred telegraphic patents were taken out yearly; in 1862 (the year which begins Mr. Preece's table) they fell to fifty-one, and have kept about the same number since. Another point worth stating is, that while the number of English telegraph patents taken out yearly is now for some reason stationary, the number of American ones patented in England is on the increase, even although American inventors are not at all sanguine of their adoption in England. We do not doubt that the American patent registry would show an ever increasing number of telegraph patents yearly. We hardly need to remind our readers, however, that the mere number of patents taken out is no very weighty argument against the thesis that successful telegraphic invention is suffering in England just now. It is not the number of patents taken out during given periods that should be compared, but rather the proportion of practical results they have yielded. It is the inventor's peculiar complaint that his patents, when taken out, are allowed to perish in neglect.

As we have before said, it is not the individual management and enterprise of the Government service which is at fault. As we believe that the Postal Telegraph system is a benefit to the community at large, so we believe that its officers are to be commended for their zeal and practical ability; but it is not a question of men; it is a question of system. We feel sure that Mr. W. H. Preece, and his colleagues, will frankly receive inventions and have them tried, when requested to do so. But the merits of an invention should be left to the decisions of no single individual; for all men have their peculiar biasses, opinions, and humours, which, willy nilly, sway their judgments. Inventors, as Mr. Preece says, may be a jealous and troublesome race, but that is all the more reason that the causes for their mistrust should be removed. We confess to no little astonishment when Mr. Preece tells us, in one of his too terse sentences, that "practical inventions rarely emanate from without." Was not Arkwright a barber, and Watt an optician? To go no further than the names of inventors furnished by Mr. Preece himself, was not Bain a clockmaker, Morse an artist, Wheatstone a professor of acoustics, Thomson a professor of physics? No single name of the list of English inventors given by Mr. Preece belongs to the Postal Telegraph service. The officers of that service, no doubt, effect some small improvements on apparatus submitted to their care; but it is not to them that we must look for inventions. Mr. Preece must know that inventive genius is a spontaneous article, and cannot be furnished on demand by any corps of officials, however well trained; it is from the whole country that the indigenous supply must be drawn. The total of inventive ability produced by the nation yearly is, perhaps in general, a constant quantity; but the sphere to which it devotes itself is greatly influenced by external circumstances. If the conditions for telegraphic invention are ungenial it will simply turn itself to other fields. In the discussion following Mr. Preece's paper, Prof. Graham Bell strikingly showed how little encouragement was to be got by an uninfluential inventor under the existing Postal Telegraph system in England. In 1874, in desiring to submit his multiple telegraph to the department, he was informed that it would be tried *at his own expense;* and, if successful, *the question of remuneration would be left to the Postmaster-General.* This reply caused him to bring forward his invention in America, and the outcome was the speaking telephone.

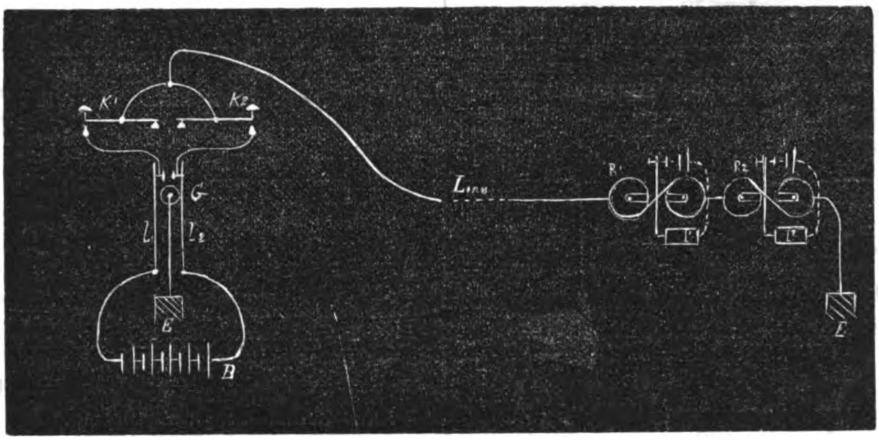
These remarks of Prof. Bell, and the letter of Mr. Herring in the *Journal of the Society of Arts* for August 30th, reveal a state of things which, independently of the general proposition in dispute, call for a reformation. As we have said before, it is the existing system which is defective, if indeed there be any system at all, and a more satisfactory one must be substituted for it as speedily as possible. In France, and in other Continental countries where a Government telegraph service exists, there is a special commission of eminent electricians, of diverse views and experience, appointed by Government to sit at certain periods to consider all telegraphic inventions brought before them. Any of these which are considered meritorious are forthwith fostered; a sum being granted to the inventor to develope it, and other facilities afforded him for experimenting. If successful, it is then recommended by them to the Government officials for adoption into the service, and they also fix the amount of remuneration to be paid for it. It is to the beneficent working of this system that the French Telegraphic Annexe at the Paris Exhibition this year owes so many novelties, and puts the British section to the blush; nearly every electrical mechanician of note in Paris, and these are to be numbered literally by the score, having some novelty to show which the French Government has aided him to produce. How different is the tale in England!

These remarks have led us to an unusual length; but the subject is one of crying importance. We cannot conclude without urging on the Postmaster

General to take steps to introduce the French system, or one analogous to it, in England. A mere reference to individual advisers, such as was resorted to in the case of Mr. Herring, only shows that the want of a commission was felt, but not supplied. We will rest now in the hope that a competent commission will ere long be appointed; for without it the fault of the present system will inevitably stifle telegraphic invention.

SIEUR'S DOUBLE TRANSMISSION TELEGRAPH SYSTEM.

The principle of this system is shown by the figure l_1, and l_2, are spring contact levers connected to the poles of a battery B. These levers normally make contact with stops connected with the front contacts of keys K_1 and K_2. A cam C, connected to earth, is kept in very rapid rotation by means of clockwork, and the levers, by this means, are caused to oscillate alternately, with extreme rapidity, to and fro from their contact stops. The result of this arrangement is, that if key K_1 is depressed, a rapid succession of currents of one sign are caused to pass out to line; and if K_2 be depressed, a rapid succession of currents of the opposite sign pass to line; whilst if both keys be depressed, then both positive and negative currents succeeding one another with great speed, will flow.



The line wire leads to a pair of polarised relays R_1 and R_2 so connected up, that one responds to positive and the other to negative currents, each operating a local battery connected with receiving instruments I_1, I_2.

As the positive and negative currents alternate, the one set of signals does not interfere with the other set, and as the succession of impulses of either sign is rapid, the effect on each receiver does not practically differ from that produced by a continued current of the sign for which the receiver is adapted.

Several modifications of the arrangement just described are proposed by M. Sieur; thus, the relay tongues may normally be held over to their insulating stops by the succession of currents, the depression of the keys being made to cut off the currents of either sign. The receiving apparatus also, may be a single relay provided with two tongues oppositely polarised. Again, two batteries may be employed to give the opposite currents, the cam in this case putting earth on to each battery alternately; indeed, the modifications of which the principle is susceptible are very numerous, as must be evident.

By duplexing the arrangement in the ordinary way, quadruplex working is obtained.

We understand that M. Sieur's system is in successful operation on the Continent.

The apparatus is shown in the Telegraphic Annexe of the Paris Exhibition.

A NEW GALVANOMETER SHUNT BOX.

By H. R. KEMPE.

When a galvanometer has a shunt of any particular marked value inserted between its terminals, the reduction in the deflection will not be proportional to that marked value; thus, if a galvanometer be joined up in circuit with a battery, and a certain deflection be produced, then the insertion of the $\frac{1}{10}$th shunt will not reduce the deflection by $\frac{1}{10}$th, but by a larger fractional value. This arises from the fact that the total resistance in the battery circuit is reduced by the introduction of the shunt. In order to effect the reduction of the deflection to the marked value, it is necessary to introduce with the shunt a "compensating" resistance which shall cause the total resistance to remain unaltered. If galvanometers provided with shunts were also provided with such "compensating" resistances, much calculation would be avoided in making experiments. In the present article the author proposes to show how these compensating resistances can be attached to galvanometers, and how their values may be calculated.

Let S, S_1, S_2, be shunts which can be connected to the galvanometer by inserting plugs at A, B, or C.

Let r_1, r_2, r_l be compensating resistances, and let

$$r_1 + r_2 + r_l = R_1 \qquad (1)$$
$$r_2 + r_l = R_2 \qquad (2)$$

Now, what we have to do, is to find what values of S, S_1, S_2, and r_1, r_2, r_l, are necessary, so that when a plug is introduced either at A, B, or C, the resistance between D and E shall always be the same, whilst the necessary portion of the currrent is shunted off from the galvanometer.

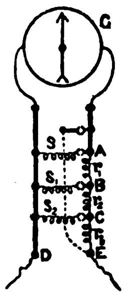


Fig. 1.

Let us first consider the shunt S and the compensating resistance which in this case, will be R_1.

When the shunts and compensating resistances are not in use, the resistance in circuit is of course G, and this value must always be preserved between D and E.

Let the value of the shunt S required be $\frac{1}{n}$th, then we know that the resistance of S necessary to give this, is

$$S = \frac{G}{n-1}$$

By the insertion of this shunt the resistance between the terminals of the galvanometer is reduced to

$$\frac{G\,S}{G+S} = \frac{G\,\frac{G}{n-1}}{G + \frac{G}{n-1}} = \frac{\frac{G}{n-1}}{1 + \frac{1}{n-1}} = \frac{G}{n} \qquad (3)$$

consequently the resistance which should be given to R_1 to bring the resistance between D and E up to G, will be

$$R_1 = G - \frac{G}{n} = G\,\frac{n-1}{n} \qquad (4)$$

We next have to consider what value to give to S_1 and R_2.

Let it be required to reduce the deflection by $\frac{1}{n_1}$th, then the value to be given to S_1 will be

$$S_1 = \frac{G + r_1}{n_1 - 1}$$

to solve which, we must know the value of r_1.

Now, the combined resistance of the shunt and $G + r_1$ we can see from (3) is

$$\frac{G + r_1}{n_1}$$

herefore the value required to be given to R_2, in order to preserve the resistance between D and E, equal to G, when S_2 is connected, will be

$$R_2 = G - \frac{G + r_1}{n_1}$$

or

$$R_2 + \frac{r_1}{n_1} = G\,\frac{n_1 - 1}{n_1} \qquad (5)$$

but from (1), (2), and (4)

$$R_2 + r_1 = R_1 = G\,\frac{n-1}{n} \qquad (6)$$

therefore, substracting (6) from (5), we have

$$\frac{r_1}{n_1} - r_1 = G\left(\frac{n_1 - 1}{n} - \frac{n-1}{n}\right) = G\,\frac{n_1 - n}{n\,n_1}$$

that is

$$r_1\,\frac{1 - n_1}{n_1} = G\,\frac{n_1 - n}{n\,n_1}$$

or

$$r_1 = G\,\frac{(n - n_1)}{n\,(n_1 - 1)}$$

consequently the value of S_2 will be

$$S_1 = G\,\frac{1 + \frac{n - n_1}{n\,(n_1 - 1)}}{n_1 - 1} = G\,\frac{(n-1)\,n_1}{n\,(n_1 - 1)^2}$$

In like manner it could be shown that the resistance necessary to give S_2 and $r_1 + r_2$ to reduce the deflection to its $\frac{1}{n_2}$th part would be

$$S_2 = G\,\frac{(n-1)\,n_2}{n\,(n_2 - 1)^2}$$

and

$$r_1 + r_2 = G\,\frac{n - n_2}{n\,(n_2 - 1)}$$

or

$$r_2 = G\,\frac{n - n_2}{n\,(n_2 - 1)} - r_1$$

Finally we have from (1) and (4)

$$r_l = R_1 - (r_1 + r_2) = G\,\frac{n-1}{n} - (r_1 + r_2)$$

To summarise then,

$$S = G\,\frac{1}{n-1}$$
$$S_1 = G\,\frac{(n-1)\,n_1}{n\,(n_1 - 1)^2}$$
$$S_2 = G\,\frac{(n-1)\,n_2}{n\,(n_2 - 1)^2}$$

and for any other shunt S_p

$$S_p = G\,\frac{(n-1)\,n_p}{n\,(n_p - 1)^2}$$

The compensating resistances *between* the shunts will be

$$r_1 = G\,\frac{n - n_1}{n\,(n_1 - 1)}$$
$$r_2 = G\,\frac{n - n_2}{n\,(n_2 - 1)} - r_1$$

and also we have

$$r_1 + r_2 + \ldots + r_p = G\,\frac{n - n_p}{n_p - 1}$$

or

$$r_p = G\,\frac{n - n_p}{n\,(n_p - 1)} - (r_1 + r_2 + \ldots + r_{p-1})$$

The *last* resistance r_l beyond the last shunt will be

$$r_l = G\,\frac{n-1}{n} - (r_1 + r_2 + \ldots + r_p)$$

For example.

It was required to provide a galvanometer with $\frac{1}{10}$th, $\frac{1}{100}$th, and $\frac{1}{1000}$th shunts, and with correspond-

ing compensating resistances arranged according to fig. 1. What should be their value?

We have

$$n = 1000,\ n_1 = 100,\ n_2 = 10$$

therefore

$$n - 1 = 999,\ n_1 - 1 = 99,\ n_2 - 1 = 9$$

Then

$$s = G\,\frac{1}{999} = G \times \cdot001001$$

$$s_1 = G\,\frac{999 \times 100}{1000 \times 99 \times 99} = G \times \cdot010193$$

$$s_2 = G\,\frac{999 \times 10}{1000 \times 9 \times 9} = G \times \cdot12333$$

and

$$r_1 = G\,\frac{1000 - 100}{1000 \times 99} = G \times \cdot0090909$$

$$r_1 + r_2 = G\,\frac{1000 - 10}{1000 \times 9} = G \times \cdot11$$

from which

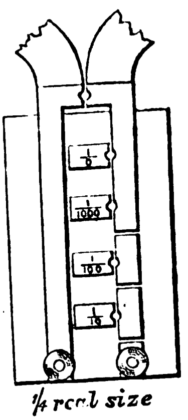
$$r_2 = G\,(\cdot11 - \cdot0090909) = G \times \cdot1009091$$

also

$$r = G\,\frac{999}{1000} - (r_1 + r_2) = G\,(\cdot999 - \cdot11) = G \times \cdot889$$

If the resistance of the galvanometer, for which these shunts and compensating resistances are to be provided, is 5,000 ohms, then

$$s = 5000 \times \cdot001001 = 5\cdot006 \text{ ohms.}$$
$$s_1 = 5000 \times \cdot010193 = 50\cdot964 \quad ,,$$
$$s_2 = 5000 \times \cdot12333 = 616\cdot667 \quad ,,$$
$$r_1 = 5000 \times \cdot0090909 = 45\cdot455 \quad ,,$$
$$r_2 = 5000 \times \cdot1009091 = 504\cdot545 \quad ,,$$
$$r = 5000 \times \cdot889 = 4445\cdot000 \quad ,,$$



¼ real size

Fig. 2

Fig. 2 shows how an ordinary Thomson galvanometer shunt box would be arranged with compensating resistances.

The plug hole marked $\frac{1}{0}$, when it has a plug inserted in it, connects the top left hand brass block to the bottom left hand block, and so leaves the galvanometer connected to the terminals of the shunt box without any additional resistance in its circuit. The connection between the brass blocks is shown by the dotted line in Fig. 1.

THE BRITISH ASSOCIATION.

ADDRESS OF WILLIAM SPOTTISWOODE, ESQ., M.A., D.C.L., L.L.D., F.R.S., F.R.A.S., F.R.G.S., PRESIDENT.

(Concluded from page 356.)

It has often been asked whether modern research in the field of Pure Mathematics has not so completely outstripped its physical applications as to be practically useless; whether the analyst and geometer might not now, and for a long time to come, fairly say, "hic artem remumque repono," and turn his attention to Mechanics and to Physics. That the Pure has outstripped the Applied is largely true; but that the former is on that account useless is far from true. Its utility often crops up at unexpected points; witness the aids to classification of physical quantities, furnished by the ideas (of Scalar and Vector) involved in the Calculus of Quaternions; or the advantages which have accrued to Physical Astronomy from Lagrange's Equations, and from Hamilton's Principle of Varying Action; on the value of Complex Quantities, and the properties of general Integrals, and of general theorems on integration for the Theories of Electricity and Magnetism. The utility of such researches can in no case be discounted, or even imagined beforehand; who, for instance, would have supposed that the Calculus of Forms or the Theory of Substitutions would have thrown much light upon ordinary equations; or that Abelian Functions and Hyperelliptic Transcendents would have told us anything about the properties of curves; or that the Calculus of Operations would have helped us in any way towards the figure of the Earth? But upon such technical points I must not now dwell. If, however, as I hope, it has been sufficiently shown that any of these more extended ideas enable us to combine together, and to deal with as one, properties and processes which from the ordinary point of view present marked distinctions, then they will have justified their own existence; and in using them we shall not have been walking in a vain shadow, nor disquieting our brains in vain.

These extensions of mathematical ideas would, however, be overwhelming, if they were not compensated by some simplifications in the processes actually employed. Of these aids to calculation I will mention only two, viz., symmetry of form, and mechanical appliances; or, say, Mathematics as a Fine Art, and Mathematics as a Handicraft. And first, as to symmetry of form. There are many passages of algebra in which long processes of calculation at the outset seem unavoidable. Results are often obtained in the first instance through a tangled maze of formulæ, where at best we can just make sure of our process step by step, without any general survey of the path which we have traversed, and still less of that which we have to pursue. But almost within our own generation a new method has been devised to clear this entanglement. More correctly speaking, the method is not new, for it is inherent in the process of algebra itself, and instances of it, unnoticed perhaps or disregarded, are to be found cropping up throughout nearly all mathematical treatises. By Lagrange, and to some extent also by Gauss, among the old writers, the method of which I am speaking was recognised as a principle; but besides these perhaps no others can be named until a period within our own recollection. The method consists in symmetry of expression. In algebraical formulæ combinations of the quantities entering therein occur and recur; and by a suitable choice of these quantities the various combinations may be rendered symmetrical, and reduced to a few well known types. This having been done, and one such combination having been calculated, the remainder, together with many of their results, can often be written down at once, without further

calculations, by simple permutations of the letters. Symmetrical expressions, moreover, save us much time and trouble in reading as in writing. Instead of wading laboriously through a series of expressions which, although successively dependent, bear no outward resemblance to one another, we may read off symmetrical formulæ, of almost any length, at a glance. A page of such formulæ becomes a picture: known forms are seen in definite groupings; their relative positions, or perspective, as it may be called, their very light and shadow, convey their meaning almost as much through the artistic faculty as through any conscious ratiocinative process. Few principles have been more suggestive of extended ideas or of new views and relations than that of which I am now speaking. In order to pass from questions concerning plane figures to those which appertain to space, from conditions having few degrees of freedom to others which have many—in a word, from more restricted to less restricted problems—we have in many cases merely to add lines and columns to our array of letters or symbols already formed, and then read off pictorially the extended theorems.

Next as to mechanical appliances. Mr. Babbage, when speaking of the difficulty of ensuring accuracy in the long numerical calculations of theoretical astronomy, remarked, that the science which in itself is the most accurate and certain of all had, through these difficulties, become inaccurate and uncertain in some of its results. And it was doubtless some such consideration as this, coupled with his dislike of employing skilled labour where unskilled would suffice, which led him to the invention of his calculating machines. The idea of substituting mechanical for intellectual power has not lain dormant; for besides the arithmetical machines whose name is legion (from Napier's Bones, Earl Stanhope's calculator, to Schultz and Thomas's machines now in actual use) an invention has lately been designed for even a more difficult task. Prof. James Thomson has in fact recently constructed a machine which, by means of the mere friction of a disc, a cylinder, and a ball, is capable of effecting a variety of the complicated calculations which occur in the highest application of mathematics to physical problems. By its aid it seems that an unskilled labourer may, in a given time, perform the work of ten skilled arithmeticians. The machine is applicable alike to the calculation of tidal, of magnetic, of meteorological, and perhaps also of all other periodic phenomena. It will solve differential equations of the second and perhaps of even higher orders. And through the same invention the problem of finding the free motions of any number of mutually attracting particles, unrestricted by any of the approximate suppositions required in the treatment of the Lunar and Planetary Theories, is reduced to the simple process of turning a handle.

When Faraday had completed the experimental part of a physical problem, and desired that it should thenceforward be treated mathematically, he used irreverently to say, "Hand it over to the calculators." But truth is ever stranger than fiction; and if he had lived until our day, he might with perfect propriety have said, "Hand it over to the machine."

Had time permitted, the foregoing topics would have led me to point out that the mathematician, although concerned only with abstractions, uses many of the same methods of research as are employed in other sciences, and in the arts, such as observation, experiment, induction, imagination. But this is the less necessary because the subject has been already handled very ably, although with greater brevity than might have been wished, by Professor Sylvester in his address to Section A at our meeting at Exeter.

In an exhaustive treatment of my subject there would still remain a question which in one sense lies at the bottom of all others, and which through almost all time has had an attraction for reflective minds, viz., what was the origin of mathematical ideas? Are they to be regarded as independent of, or dependent upon, experience? The question has been answered sometimes in one way and sometimes in another. But the absence of any satisfactory conclusion may after all be understood as implying that no answer is possible in the sense in which the question is put; or rather that there is no question at all in the matter, except as to the history of actual facts. And, even if we distinguish, as we certainly should, between the origin of ideas in the individual and their origin in a nation or mankind, we should still come to the same conclusion. If we take the case of the individual, all we can do is to give an account of our own experience; how we played with marbles and apples; how we learnt the multiplication table, fractions, and proportion; how we were afterwards amused to find that common things conformed to the rules of number; and later still how we came to see that the same laws applied to music and to mechanism, to astronomy, to chemistry, and to many other subjects. And then, on trying to analyse our own mental processes, we find that mathematical ideas have been imbibed in precisely the same way as all other ideas, viz., by learning, by experience, and by reflection. The apparent differences in the mode of first appending them and in their ultimate cogency arises from the difference of the ideas themselves, from the preponderance of quantitative over qualitative considerations in mathematics, from the notions of absolute equality and identity which they imply.

If we turn to the other question, How did the world at large acquire and improve its idea of number and of figures? How can we span the interval between the savage who counted only by the help of outward objects to whom 15 was "half the hands and both the feet," and Newton or Laplace? The answer is the history of mathematics and its successive developments, arithmetic, geometry, algebra, &c. The first and greatest step in all this was the transition from number in the concrete to number in the abstract. This was the beginning not only of mathematics but of all abstract thought. The reason and mode of it was the same as in the individual. There was the same general influx of evidence, the same unsought-for experimental proof, the same recognition of general laws running through all manner of purposes and relations of life. No wonder then if, under such circumstances, mathematics, like some other subjects and perhaps with better excuse, came after a time to be clothed with mysticism; nor that, even in modern times, they should have been placed upon an *à priori* basis, as in the philosophy of Kant. Number was so soon found to be a principal common to many branches of knowledge that it was readily assumed to be the key to all. It gave distinctness of expression, if not clearness of thought, to ideas which were floating in the untutored mind, and even suggested to it new conceptions. In "the one," "the all," "the many in one" (terms of purely arithmetic origin), it gave the earliest utterance to men's first crude notions about God and the world. In "the equal," "the solid," "the straight," and "the crooked," which still survive as figures of speech among ourselves, it supplied a vocabulary for the moral notions of mankind, and quickened them by giving them the power of expression. In this lies the great and enduring interest in the fragments which remain to us of the Pythagorean philosophy.

The consecutive processes of Mathematics led to the consecutive processes of Logic; but it was not until long after mankind had attained to abstract ideas that they attained to any clear notion of their connexion with one another. In process of time the leading ideas of Mathematics became the leading ideas of Logic. The "one" and the "many" passed into the "whole" and its "parts;" and thence into the "universal" and the "particular." The fallacies of Logic, such as the well-known puzzle of Achilles and the tortoise, partake of the nature of both

sciences. And perhaps the conception of the infinite and the infinitesimal, as well as of negation, may have been in early times transferred from Logic to Mathematics. But the connexion of our ideas of number is probably anterior to the connexion of any of our ideas. And as a matter of fact, geometry and arithmetic had already made considerable progress when Aristotle invented the syllogism.

General ideas there were, beside those of mathematics—true flashes of genius which saw that there must be general laws to which the universe conforms, but which saw them only by occasional glimpses, and through the distortion of imperfect knowledge; and although the only records of them now remaining are the inadequate representations of later writers, yet we must still remember that to the existence of such ideas is due not only the conception but even the possibility of Physical Science. But these general ideas were too wide in their grasp, and in early days at least were connected in their subject of application by links too shadowy, to be thoroughly apprehended by most minds; and so it came to pass that one form of such an idea was taken as its only form, one application of it as the idea itself; and philosophy, unable to maintain itself at the level of ideas, fell back upon the abstractions of sense, and by preference, upon those which were most ready to hand, namely, those of mathematics. Plato's ideas relapsed into a doctrine of numbers; mathematics into mysticism, into neo-Platonism, and the like. And so, through many long ages, through good report and evil report, mathematics have always held an unsought-for sway. It has happened to this science as to many other subjects, that its warmest adherents have not always been its best friends. Mathematics have often been brought into matters where their presence has been of doubtful utility. If they have given precision to literary style, that precision has sometimes been carried to excess, as in Spinoza and perhaps Descartes; if they have tended to clearness of expression in philosophy, that very clearness has sometimes given an appearance of finality not always true; if they have contributed to definition in theology, that definiteness has often been fictitious, and has been attained at the cost of spiritual meaning. And, coming to recent times, although we may admire the ingenuity displayed in the logical machines of Earl Stanhope and of Stanley Jevons, in the "Formal Logic" of De Morgan, and in the "Calculus" of Boole; although as mathematicians we may feel satisfaction that these feats (the possibility of which was *à priori*) have been actually accomplished; yet we must bear in mind that their application is really confined to cases where the subject-matter is perfectly uniform in character, and that beyond this range they are perfectly liable to encumber rather than to assist thought.

Not unconnected with this intimate association of ideas and their expression is the fact that, whichever may have been cause, whichever effect, or whether both may not in turn have acted as cause and effect, the culminating age of classic art was contemporaneous with the first great development of mathematical science. In an earlier part of this discourse I have alluded to the importance of mathematical precision recognised in the technique of art during the Cinquecento; and I have now time only to add that on looking still further back it would seem that sculpture and painting, architecture and music, nay even poetry itself, received a new, if not their first true, impulse at the period when geometric form appeared fresh chiselled by the hand of the mathematician, and when the first ideas of harmony and proportion rang joyously together in the morning tide of art.

Whether the views on which I have here insisted be in any way novel, or whether they be merely such as from habit or from inclination they are usually kept out of sight, matters little. But whichever be the case, they may still furnish a solvent of that rigid aversion which both Literature and Art are too often inclined to maintain towards Science of all kinds. It is a very old story that, to know one another better, to dwell upon similarities rather than upon diversities, are the first stages towards a better understanding between two parties; but in few cases has it a truer application that in that here discussed. To recognise the common growth of scientific and other instincts until the time of harvest is not only conducive to a rich crop, but it is also a matter of prudence, lest in trying to root up weeds from among the wheat, we should at the same time root up that which is as valuable as wheat. When Pascal's father had shut the door of his son's study to mathematics, and closeted him with Latin and Greek, he found on his return the walls were teeming with formulæ and figures, the more congenial product of the boy's mind. Fortunately for the boy, and fortunately also for Science, the mathematics were not torn up, but were suffered to grow together with other subjects. And all said and done, the lad was not the worse scholar or man of letters in the end. But, truth to tell, considering the severance which still subsists in education and during our early years between Literature and Science, we can hardly wonder if when thrown together in the afterwork of life they should meet as strangers; or if the severe garb, the curious implements, and the strange wares of the latter should seem little attractive when contrasted with the light companionship of the former. The day is yet young, and in the early dawn many things look weird and fantastic which in fuller light prove to be familiar and useful. The outcomings of Science, which at one time have been deemed to be but stumbling-blocks scattered in the way, may ultimately prove stepping stones which have been carefully laid to form a pathway over difficult places for the children of "sweetness and of light."

The instances on which we have dwelt are only a few out of many in which Mathematics may be found ruling and governing a variety of subjects. It is as the supreme result of all experience, the framework in which all the varied manifestations of nature have been set, that our science has laid claim to be the arbiter of all knowledge. She does not indeed contribute elements of fact, which must be sought elsewhere; but she sifts and regulates them: she proclaims the laws to which they must conform if those elements are to issue in precise results. From the data of a problem she can infallibly extract all possible consequences, whether they be those first sought, or others not anticipated; but she can introduce nothing which was not latent in the original statement. Mathematics cannot tell us whether there be or be not limits to time or space; but to her they are both of indefinite extent, and this in a sense which neither affirms or denies that they are either infinite or finite. Mathematics cannot tell us whether matter be continuous or discreet in its structure; but to her it is indifferent whether it be one or the other, and her conclusions are independent of either particular hypothesis. Mathematics can tell us nothing of the origin of matter, of its creation or its annihilation; she deals only with it in a state of existence; but within that state its modes of existence may vary from our most elementary conception to our most complex experience. Mathematics can tell us nothing beyond the problems which she specifically undertakes; she will carry them to their limit, but there she stops, and upon the great region beyond she is imperturbably silent.

Conterminous with space and coëval with time is the kingdom of Mathematics; within this range her dominion is supreme; otherwise than according to her order nothing can exist; in contradiction to her laws nothing takes place. On her mysterious scroll is to be found written for those who can read it that which has been, that which is, and that which is to come. Everything material which is the subject of knowledge

has number, order, or position; and these are her first outlines for a sketch of the universe. If our more feeble hands cannot follow out the details, still her part has been drawn with an unerring pen, and her work cannot be gainsayed. So wide is the range of mathematical science, so indefinitely may it extend beyond our actual powers of manipulation, that at some moments we are inclined to fall down with even more than reverence before her majestic presence. But so strictly limited are her promises and powers, about so much that we might wish to know does she offer no information whatever, that at other moments we are fain to call her results but a vain thing, and to reject them as a stone when we had asked for bread. If one aspect of the subject encourages our hopes, so does the other tend to chasten our desires; and he is perhaps the wisest, and in the long run the happiest among his fellows, who has learnt not only this science, but also the larger lesson which it indirectly teaches, namely, to temper our aspirations to that which is possible, to moderate our desires to that which is attainable, to restrict our hopes to that of which accomplishment, if not immediately practicable, is at least distinctly within the range of conception. That which is at present beyond our ken may, at some period and in some manner as yet unknown to us, fall within our grasp; but our science teaches us, while ever yearning with Goethe for "Light, more light," to concentrate our attention upon that of which our powers are capable, and contentedly to leave for future experience the solution of problems to which we can at present say neither yea nor nay.

It is within the region thus indicated that knowledge in the true sense of the word is to be sought. Other modes of influence there are in society and in individual life, other forms of energy beside that of intellect. There is the potential energy of sympathy, the actual energy of work; there are the vicissitudes of life, the diversity of circumstance, health, and disease, and all the perplexing issues, whether for good or for evil, of impulse and of passion. But although the book of life cannot at present be read by the light of Science alone nor the wayfarers be satisfied by the few loaves of knowledge now in our hands; yet it would be difficult to overstate the almost miraculous increase which may be produced by a liberal distribution of what we already have, and by a restriction of our cravings within the limits of possibility.

In proportion as method is better than impulse, deliberate purpose than erratic action, the clear glow of sunshine than irregular reflexion, and definite utterances than an uncertain sound; in proportion as knowledge is better than surmise, proof than opinion; in that proportion will the mathematician value a discrimination between the certain and the uncertain, and a just estimate of the issues which depend upon one motive power or the other. While on the one hand he accords to his neighbours full liberty to regard the unbeknown in whatever way they are led by the noblest powers that they possess; so on the other he claims an equal right to draw a clear line of demarcation between that which is a matter of knowledge, and that which is at all events something else, and to treat the one category as fairly claiming our assent, the other as open to further evidence. And yet, when he sees around him those whose aspirations are so fair, whose impulses so strong, whose receptive faculties so sensitive, as to give objective reality to what is often but a reflex from themselves, or a projected image of their own experience, he will be willing to admit that there are influences which he cannot as yet either fathom or measure, but whose operation he must recognise among the facts of our existence.

THE MICROPHONE.

On a New Form of Receiving Instrument for the Microphone.

By W. J. MILLAR, C.E., Secretary of the Institution of Engineers and Shipbuilders, in Scotland.

Read before Section A of the British Association.

The object of the present paper is to describe a new form of receiving instrument for the microphone, as devised by the author.

In a paper communicated to the Physical Society of London, on March 16, 1878, the author gave a detailed account of some experiments which he had been carrying out upon the transmission of sound by various substances without the aid of electricity or magnetism.

Some very curious results were obtained from these experiments, wires being extended in various ways from point to point through buildings, and carried to distances in the open air. These wires were in some cases laid upon the carpets from room to room, and the doors shut upon them. Yet in all these cases communications could be carried on between persons situated at each end of the wire.

The transmitting and receiving parts were simple discs set in deep or shallow rims—as the case might be—the connecting wire being fastened to the centre of each disc. The discs found most suitable were of pasteboard.

In all such transmission the vocal or other sounds were taken up from the air by the disc of the mouthpiece, and changed into vibratory movements of the materials in connexion; finally arriving at the receiving disc of the earpiece, and given out again to the air as sonorous vibrations. In studying the various phenomena presented, it occurred to the author that, as the particles of the wire and connexions must be in a state of rapidly varying strain, that if an electric current were circulating through the wire at the time of transmission of sound, the strains due to the vibrations of the particles of the wire might act upon the current so as to be reproduced by suitable means at the other end of the circuit.

The announcement of Professor Hughes' discovery of the microphone at once showed that the various states of strain in a substance or substances in contact, was sufficient to cause corresponding changes in the flow of an electric current passing at the time through the wire, whereby vocal sounds could be transmitted.

After some experiments with the microphone, the author placed a small pocket compass, having a number of turns of the conducting wire round it, and noted the motion of the needle as sounds were emitted close to the transmitter (the transmitter used was a piece of pointed carbon resting upon a piece of coke); variations in the motion of the needle were then observed, and differing for different sounds.

A small sewing needle was magnetised and suspended in a light pasteboard frame. A few turns of fine wire were passed along it so as to form a light galvanometer; distinct taps were then heard as the current was interrupted.

After some experimenting in this manner, it occurred to the author that if the needle were fixed, then, instead of moving when the current passed, it would be thrown into a state of strain, and as conditions of varying strain in the bodies experimented on in the experiments formerly referred to had been found to produce sound, then, when such state of strain was induced in the magnetic needle, sound would be the result, and that the flow of the current, as modified by the microphone transmitter, would reproduce through this straining action of the needle receiver the sounds emitted at the transmitter.

In order to test this a few yards of No. 30 covered copper wire were passed lengthwise along a small bar magnet

3 in. long, when it was found that upon breaking contact faint sounds were heard when the magnet was held to the ear. By placing the magnet against the lid of a pasteboard box the sounds were much intensified.

Thinking that a stronger magnet would give better results, the author took a horseshoe magnet 6 in. long, and laid along one half of it from two to three yards of the same wire; a much louder sound was then heard, and by placing the lid of a tin box on the flat side of the ends of the magnet an excellent receiving instrument was obtained. With this, singing, whistling, speaking, and violin music were readily rendered audible.

The battery consisted of a single Leclanché cell, the transmitter being two pieces of carbon pencil attached to wires in circuit, and slightly touching each other at their points. One of these wires rested upon an upright pasteboard box, into which the sounds were directed.

In making some further experiments, the small bar magnet was found quite suitable, and the receiver, as now exhibited to the meeting, has acted well, although of such small dimensions. The magnet is 3 in. long, $\frac{5}{16}$ in. broad, and fully $\frac{3}{16}$ in. thick, and has about six yards of No. 30 covered wire passed along its longer axis; it is placed in a shallow pasteboard box with two tin plates above and below it; the lid being placed on constitutes the whole an easily portable pocket instrument.

With a comparitively simple arrangement and with a single Leclanché cell, speaking, whistling, breathing, &c., are readily transmitted.

The author has been unable, from other duties, to follow up these experiments so far as to show what sizes and arrangements are best, but from the very satisfactory results got from the arrangements tried, he believes that there is a very interesting field of inquiry in the direction indicated, which he believes warrants him in bringing the subject before the members of the British Association.

Since the foregoing was written, the author has found that sounds can be obtained without a magnet, the receiver being simply a piece of tin around which a few yards of covered copper wire is wound; the various microphone phenomena can be exhibited with this simple receiver; the sounds, however, are very much reduced in loudness.

ON UNILATERAL CONDUCTIVITY IN TOURMALINE CRYSTALS.

By Professor SILVANUS P. THOMPSON, and Dr. OLIVER J. LODGE.

Abstract of Paper read before Section A, British Association, August 20th, 1878.

THE authors regarded the phenomena of pyroelectricity as exhibited by the tourmaline and other crystals as of the utmost significance in the theory of the relation of electricity to the particles of matter. Dr. Lodge had read a paper at the British Association meeting at Glasgow on a mechanical model illustrating the flow of an electric current through a circuit. The considerations therein advanced had independently led the authors to conclude that the phenomena of pyroelectricity could be explained if it could be shown that such crystals as were pyroelectric possessed unilateral conductivity. The principal phenomenon of pyroelectricity was this: that a tourmaline crystal whilst its temperature was being raised became positively electrical at that end called the analogous pole, and negatively electrical at its antilogous pole. The term "unilateral conductivity" had been given by Dr. A. Schuster to a phenomenon of some obscurity, observed by him in certain cases, and which formed the subject of a communication to a former meeting of the Association. The term unilateral conductivity was defined as follows: If the conductivity of a substance in a given direction between two points A and B, was greater (or less) when the flow was in the direction from A to B than when the flow was in the direction from B to A, then such a substance was said to possess unilateral conductivity. Mathematical analysis as yet did not apply to any such case.

It had been argued by the first of the two authors of the paper, that if the tourmaline possessed a unilateral conductivity for electricity it would also be found to possess unilateral conductivity for heat, since the researches of Tait and Kohlrausch had shewn that the two conductivities are comparable in almost all points of analogy. The experimental research therefore had divided into two branches. Delay had taken place from the difficulty of meeting with suitable specimens of tourmaline crystal, and this difficulty was eventually overcome through the kindness of Professor N. Story Maskelyne.

The method first suggested for comparing the two heat-conductivities, as measured in opposite directions along the axis of the crystal, was that of De Senarmont. A slice of the crystal was cut with parallel faces containing the crystallographic axis, and having been covered with wax, or with Meusel's double iodide of copper and mercury was heated from a point by a hot wire. When the experiment was rapidly made, the elliptical isothermal surface marked out by the melted wax or the blackened iodide was found to be displaced from the centre, and this displacement was towards the analogous pole; shewing that whilst the temperature was rising the conductivity in that direction was greater than in the opposite direction. When however the experiment was done slowly with a thicker crystal, so that thermal equilibrium was attained, no such unilateral effect could be observed. Rough preliminary experiments shewed the unequal semi-axes minor to have a ratio of about 10 to 12, but there was considerable discordance in the various results.

A calorimetric method was next adopted to measure the flow of heat across a thin wall of tourmaline cut normally to its crystallographic axis. Steam was applied below one face of the crystal, and the heat which left the upper surface of the crystal was applied to heat a quantity of mercury. Experiments with this apparatus made alternately from opposite faces of the crystal showed that, as before, the conductivity for heat was greater towards the analogous pole, so long as the temperature of the crystal was rising.

In respect of the electrical conductivity, time had only permitted a few preliminary experiments. The slice of crystal was heated in a steam bath; and then a 5 microfarad condenser charged through it by 10 or 12 Daniell's cells was discharged through a sensitive Thomson galvanometer of 7,000 ohms. resistance. The experiment was then repeated with the tourmaline reversed. A very slight but constant difference of conductivity could be detected, but only whilst the temperature was still rising or falling. The principal difficulty lay in the very great resistance of the tourmaline. The authors hoped to be able to continue the investigation using a higher temperature and a far higher electromotive force. They would like to try that of 1,000 cells.

EDISON'S ELECTRO-MOTOGRAPH.

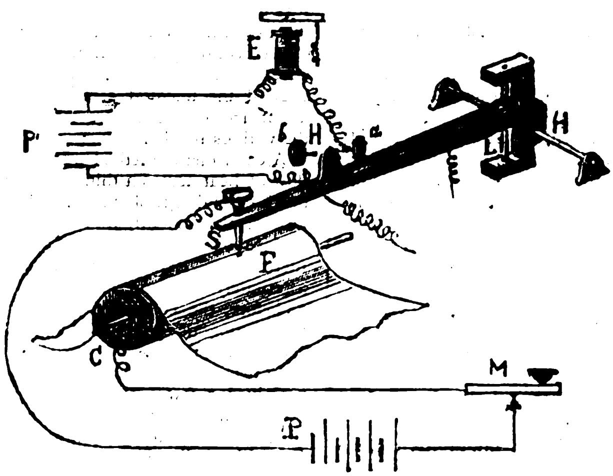
ONE of the most curious instruments exhibited by Mr. Edison—at least, as regards the effects produced by it and the applications of which it is susceptible—is the *electro-motograph*, an instrument devised as far back as 1872, and which has already been used as a telegraphic relay and telephonic receiver.

This instrument enables us to obtain mechanical

effects with an exceedingly small electric force, and upon very long circuits, without the intervention of any electro-magnetic organ. It is based upon the principle that if a sheet of slightly rough paper, steeped in certain solutions, be laid upon a platinised metallic plate, and there be passed over it a strip of sheet metal, preferably lead or thallium, but which may be of platinum, on the passage of a current, a certain slipping of the surface is produced, which makes the friction much less and gives rise to utilisable mechanical effects. Thus by employing as rubber a jointed metal bar held in position by a spring, this bar being dragged onwards by its friction on a travelling paper band, can spring back each time a current passes, and may thus be made to close a local relay circuit. And by adapting this rubber to a sounding box and interposing it in the circuit of a battery telephone, one can obtain from the resonator, vibrations which are the counterpart of the sounds emitted in the telephone. We may in this way have a telephonic receiver without electro magnetic parts, and capable of very great sensibility. The arrangement is, however, principally applicable for musical sounds, although Mr. Adams, Mr. Edison's collaborateur, affirms that speech has been reproduced in this way.

cylinder C, which is in electric communication with the key M, and so with the negative pole of the battery P. L S is a lever pivoting vertically at L on a piece K, which is pivoted horizontally. This lever, furnished at its lower end with a platinum point, and a contact-maker H oscillating between two screws *a*, *b*, constitutes the moveable part of the relay, and is acted upon by two antagonistic springs, one of which R, tends to hold it down upon the paper by means of the points S, the other R', which tends to draw it towards the screw A in the other direction in consequence of the tractile motion of the paper and the rotation of the cylinder C. The screw A is connected with the local circuit of battery P', in which is interposed the electro-magnetic apparatus E, worked by the relay, and the point S is placed in connection with the positive pole of battery P. This point, therefore, by reason of the unequal friction it encounters, constitutes the relay.

Mr. Edison has in this way constructed relays which have worked through a million ohms, a resistance which with the battery employed, was too high for an electro-chemical apparatus with iodide of potassium, and sufficiently high to give no de flection on an ordinary galvanometer. The author remarks that as with this system there are no



The action above referred to may be easily noticed by taking the spring between the fingers, interruptions of the current causing sensible pulsations. The above effects may be produced with a number of substances, but the pole employed varies with them. Thus, when employing potassic hydrate, potassic ferrocyanide, and most of the alkalis, the rubber should be connected with the positive pole, while pyrogallic acid, strontium, nitrate, &c., require the negative. With some substances, however, such as silicate of soda, potassic, hydrate, &c., either pole may be used; and with others, such as sulphate of aniline, the effects described are produced in circuits of high resistance, but not in circuits of low resistance.

The figure shows the electro-motograph arranged as a relay. F represents the strip of sensitised paper, drawn along as in the Morse instrument, and held with a certain tension upon the metal

secondary currents due to reaction of electro-magnets, and as the electro-chemical action is instantaneous, a much greater speed can be attained than with the ordinary systems. The apparatus has, in fact, when used as a translator, transmitted over 650 words per minute, and it could even act on a Morse inker if substituted for the electro-magnet ordinarily employed.

As a telephonic receiver the electro-motograph has the following arrangement. The receiver consists of a resonator and a drum fixed on an axle turned by hand. A strip of paper passes over the drum, the surface of which is rough, and pressing upon the strip is a point similar to S in the figure, but adapted to a spring fixed to the centre of the resonator. The current passes through the spring, platinum point, and chemical paper, and returns by the drum to the battery. When the handle is turned, there results a series of vibrations which

are the reproduction, more or less faithful, of the sounds which affected the transmitter. According to the American journals this instrument can reproduce with great intensity the highest notes of the human voice, notes which can scarcely be distinguished when electro-magnets are employed.

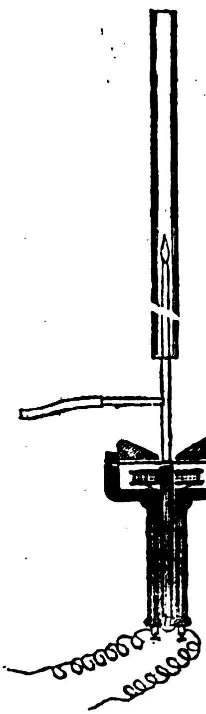
With this telephonic receiver, the transmitter is almost the same as the carbon one of the same inventor, only, instead of the carbon disc, it is a platinum point which is used, and it must not be in continuous contact with the vibrating plate. It is, in fact, analogous to the Riess telephone.

According to Mr. Adams, it is possible to transmit speech with this system when using Edison's carbon transmitter; it is, however, only referred to in the journals as a *musical telephone.*—*L'Electricité.*

A TELEPHONE ALARM.

By ALFRED CHIDDEY.

THIS arrangement, the invention of the writer, consists of a slender brass tube, eight inches in length, having an orifice of one-twentieth of an inch diameter.



At the upper end this tube is soldered to a telephone diaphragm, as shown in the figure, and a branch serves to connect it with a gas supply through the medium of an india-rubber tube. The jet being ignited at the orifice, the stop-cock is manipulated so that a flame, about half an inch high, is obtained. A glass tube, about 12-in. by $\frac{3}{4}$-in., is then passed over the flame until it commences to sing. The glass tube is now raised about an inch, and the singing stopped by placing the finger, for a moment, on the end. The telephone and glass tube being held in their respective positions, by suitable supports, the arrangement forms the alarm for one end of the circuit. A similar arrangement is adopted for the other end, care being taken that the tubes of both arrangements are similar, so that the notes produced by the two flames may coincide.

If, when the flames are silent, the note of the tubes be sounded near one of them (either by the voice or a tuning fork), then when the flame in that tube starts into vibrations, the latter will be communicated to the diaphragms of the two telephones, and this will set the flame of the second one singing also, and thus give a call signal.

EDISON'S MEGAPHONE.

FROM the time of the first man until now, men have endeavoured to circumvent nature so as to grasp that which the unaided faculties could never attain. We have telescopes for viewing remote objects, microscopes for making visible the minute, telephones for talking over immense distances, and now, at last, we have a megaphone, which is to the ear almost what the telescope is to the eye, or the telephone to the vocal organs.

The speaking trumpet, which, for two centuries at least, has been employed to direct sound so that it may be heard over a long distance, is much used at sea, and is often employed on land to direct vocal sounds so that they may be heard above other sounds. It is tolerably certain that the speaking trumpet is of modern origin, and that it is the invention of Samuel Moreland, 1670.

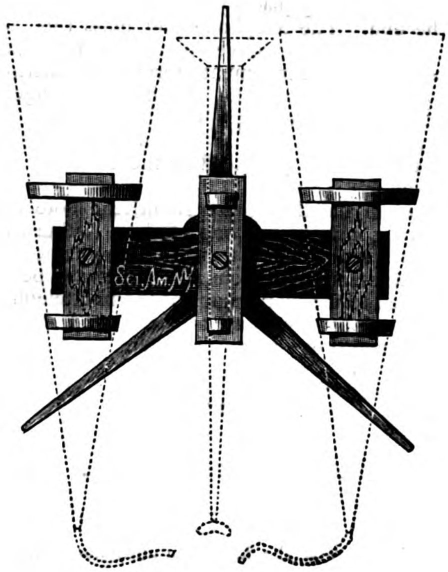
Kircher, in his *Ars Magna et Umbra* and in his *Phonurgia*, mentions a kind of gigantic speaking trumpet, described as the horn of Alexandria. According to Kircher, this horn enabled Alexander the Great to call his soldiers from a distance of ten miles. The diameter of the ring must have been eight feet, and Kircher conjectures that it was mounted on three poles.

Late in the last century Professor Huth, a German, made a model of the horn, and found that it served as a powerful speaking trumpet, but we are considerably in doubt as to the distance through which sounds can be projected through such an instrument.

The ear trumpet, which is the counterpart of the speaking trumpet, has been made in various forms during the last two centuries, but no form yet devised has any advantage over a plain conical tube with a bell-shaped or flaring mouth.

Professor Edison, in his researches on sound, has made many curious experiments, one of the most interesting of which is that of conversing through a distance of $1\frac{1}{2}$ to 2 miles with no other apparatus than a few paper funnels. These funnels constitute the megaphone, an instrument wonderful both for its simplicity and effectiveness. The two larger funnels are

6 feet 8 inches long, and $27\frac{1}{2}$ inches in diameter at the larger end. These funnels are each provided with a flexible ear tube, the end of which is placed in the ear. The speaking trumpet in the middle does not differ materially from the ordinary ones. It is a little longer,



and has a larger bell mouth. With this instrument conversation can be readily carried on through a distance of $1\frac{1}{2}$ to 2 miles. We have conversed and heard singing through the distance named, although both the singing and talking were in the ordinary tone of voice. A low whisper, uttered without using the speaking trumpet, is distinctly audible at a thousand feet, and walking through grass and weeds may be heard at a much greater distance.—*Scientific American.*

Review.

Memoir of the late Alfred Smee. By his DAUGHTER. With a Selection from his Miscellaneous Writings. George Bell and Sons, York Street, Covent Garden. 1878.

THERE is a stage in the life of a man or woman at which the mental gaze, instead of being wholly fixed on the present or the future, is sometimes turned to dwell with interest on the past. It is still a youthful stage, but it is in that advanced youth when earlier youth is so remote as to seem another kind of existence, and the career in the world has been so far won and made manifest that the whole energies are no longer employed in striving and looking forward. There is a similar era, too, in the history of a nation. In America, at the present day, there is evidence of a warm and growing love for the few antiquities which the earlier American colonisation can show. Old mansion houses of the British Governors are surrounded with a halo of historical association; poems and tales without number are written to portray the manners and incidents of the old colonial times; every scrap of information about the poets and heroes of these days is zealously collected; and this worthy enthusiasm was recently carried to so great an excess, as to mistake a weather-worn slab of rock for a runic inscription of the old Norse discoverers. Even so is it in the history of a science. Electricity is one of the youngest of the sciences, yet it is old enough, and settled enough, to begin to feel a real interest in its youth, and in the lives of those of its founders who have passed away. The electric telegraph has risen into existence within the memory of men now living; nevertheless, the men who gave it birth are one by one disappearing from the scene. Their work has been accomplished, and the many who have entered into their labours already turn with reverent eyes toward the story of their lives. The life of Alfred Smee, by his daughter, Mrs. Odling, will be welcome to a number of electricians, to whom the name of Smee is familiar as a household word, and who desire to know something of the character and life-labours of a pioneer in their science, and a contemporary of Faraday, Cooke, Bain, and Wheatstone.

Biographies by female relatives of the deceased, so common at the present time, have their advantages and disadvantages. There is a tendency on the part of a man's widow, or the daughter whom he loved, to magnify each petty detail and peculiarity of his behaviour and achievements to an undue importance; and to sweeten with the honey of their affection, certain personal traits which were a source of gall to all other parties who may have had dealings with him. Long private letters, eminently suggestive of the waste basket, are too often made a source of weariness to the reader, because they happen to excite tender feelings in the memory of the writer; and a partial and biassed view of the whole man is presented with the most charming candour. On the other hand, such biographies generally reveal to us phases of the man's home life—a subject which is always highly interesting, but one which the ordinary biographer would scruple to unveil even if it were always in his power. Everything considered, then, we think that biographies by female relatives, if they may be suspected of giving an imperfect picture of the man, at least furnish valuable supplies of material for a more correct and concise biography in the future.

The most striking feature of the life of Alfred Smee, the accomplished physician, oculist, discoverer, and inventor, was the varied nature of his pursuits. From the beginning to the end of his busy career, he devoted himself to no one subject in particular, and pursued no special road; but, on the contrary, diverged into every by-path that presented itself. As a consequence, he led a good and most useful life; but a life which diffused his energies, and weakened his fame. Wherever he saw an abuse that could be corrected, or a deficiency supplied, Alfred Smee at once undertook the task, and, what is more, invariably succeeded. If he went for a holiday to the sea-side, he was sure to discover that the fishermen needed cheap barometers or storm drums, and the fishermen straightway had them. If his holiday trip were to the Highlands instead, he championed the crofters against the landlords' game. He was either inventing something—a ventilator, a galvanic battery, an optometer, a method of printing bank notes—or

he was fighting the battle of science against the propagation of fever germs in milk and sewage, or in tracing the spread of the potato disease to the ravages of the *aphis vastator*. In 1846, the potato controversy raged to vast proportions, and Mrs. Odling gives the following amusing extract from the Drury Lane Pantomime of that year :—

SCENE.—*A Village Fair, with shows, &c., &c.*
Little boy looking at a peep-show.

Showman.—This is the *aphis vastator*, as you may see
Very much magnified by Mr. Smee.
Boy.—Please, sir, which is the aphis and which is the tater?
Showman.—Whichever you like, my young investigator.

Besides his public controversies, his lectures, experiments, and book writing, his occasional letters on lightning strokes and new comets, Smee found time to study politics, as well as attend to his professional duties as physician to the Bank of England, and other societies. But in his contests for the representation of Rochester he was always unsuccessful; the only check to his versatility which he appears to have sustained. All his spare moments were given to the preparation of his large works: *Electro-Biology*, *Instinct and Reason*, *The Eye*, the *Mind of Man*, and *My Garden*.

The *Mind of Man* contains his cherished metaphysical system, and is his greatest book.

As a writer he is, of course, gifted with unusual power of thought and fluency of expression; but he too evidently lacks that inborn sense of the beauty and fitness of words—without which no author can be distinguished for style, the touchstone of literary genius.

Smee possessed great powers of abstraction and could compose some of his most abstruse passages while others were conversing in the same room with him; and his power of memory was extraordinary, but capricious. He detested argument, and was intolerant of opposition, his mind seizing its conviction at once. He was impatient of dullness, impetuous, eager and quick to act when his rapid decision was taken; an ardent, restless, active soul, never shrinking responsibility, and full of self-trust. His keen and fervid imagination soaring after new generalisations, fostered a dislike of routine and detail which grew upon him in life and led to carelessness in dress and money matters. Withal his science, there was a high spiritual caste about his mind similar to that which sanctifies the memory of Faraday. His love of nature amounted to a kind of passion; his delight being to cultivate all kinds of flowers and fruit, and make pets of birds, gold fish, or other of our poor relations amenable to discipline. He was fond of London Society too, but only in winter; when summer came he was off to the woods and fields and to his model garden at Wallington, Surrey. He delighted in reading books of *pure* fiction and imagination, such as fairy tales, and poems, a taste not uncommon amongst men of science, who relieve the strain on the noetic faculties by flights of untrammelled fancy. Like Faraday, too, he enjoyed a comedy at the theatre, or a pantomime to his heart's content. Alfred Smee's works show him to have been an essentially religious and benevolent man; but it is pleasant to find that his kindness to the poor took the most humble and unostentatious form. No needy person ever appealed to him in vain, and when the active brain was stilled for ever, and the over-worn frame was laid beneath the turf of Beddington Churchyard, the sobs of the low as well as the high were to be heard around.

Mrs. Odling has told her father's story with much taste and good sense, leaving the selections from his writings to speak for themselves. A very fine engraved portrait by Jeens fronts the title-page, and the book is plainly but neatly bound.

Notes.

THE TELEPHONE.—The telephone will be fairly tried for military out-post work during the forthcoming autumn manœuvres of the German and French Armies.

MR. ALEXANDER MCNAE writes to *Engineering* to state that by means of a Hughes microphone transmitter, with battery, a telephone, consisting merely of a frame, coil, and vibrating disc, and without any *magnet, or other piece of iron*, will utter speech distinctly, and with moderate loudness.

WE have received from M. Alfred Niaudet a copy of his recent treatise on Telephones and Phonographs. It is a complete and comprehensive little book, printed on toned paper, and beautifully illustrated. It is published by J. Baudry, 15, Rue des Saints-Pères, Paris, We shall have occasion to refer to this work again.

THE MICROPHONE.—Mr. Alfred Chiddey has pointed out in *Nature* that the Microphone acts very well, and in some respects there is less jarring noise heard, when it is placed in a shunt or derived circuit, or the main battery and telephone circuit, *i.e.*, in such a position that when the carbon points are not in contact the whole current will flow through the telephone.

ON another page we give Mr. W. J. Millar's paper to the British Association on his microphonic researches.

THE PHONOGRAPH.—The phonograph experiments of Professors Fleeming Jenkin and J. A. Ewing confirm the theory of Helmholtz, that vowel sounds are made up of harmonic partial tones, and the groups of partials, so far as he gives them, for the vowels we have investigated, agree fairly well with their results. The vowel quality is given by a particular resonator, and the pitch of maximum resonance of the resonator, as stated by Wills and Wheatstone, is an important element in determining the vowel character of the sounds produced.

IN the near future, the bore, instead of carrying an autograph album, will have a phonograph concealed about his person, which he will produce at the unhappy moment, and request his victim to shoot a few words into it to remember him by.—*Oil City Derrick*, U.S.

THE ELECTRIC LIGHT.—At the fashionable watering place of Coney Island, near New York, the electric

light has been put to the novel purpose of illuminating the sands and the sea of Manhattan Beach, in order that bathing might go on during the cool hours of night. Three magneto-electric machines and a steam-engine are employed at the great bathing pavilions, and a light equivalent to that from 3,000 candles is shed over the water, even to a distance of several miles. The spectacular effect of the waves, and the quaint costumes of the bathers, are said to present a strange and weird scene.

TELFORD medals and Telford premiums have been awarded by the Institution of Civil Engineers to Richard William Henry Paget Higgs, L.L.D., Assoc. Inst. C.E., and John Richard Brittle, Assoc. Inst. C.E., for their paper on "Some recent improvements in Dynamo-electric apparatus."

IN the July number of *Poggendorf's Annalen* there is a translation from the works of the Arabain chemist, Abou Moussa Geber ben Hajjan, which describes an experiment proving that the loadstone loses its natural force. Geber flourished in the eighth century of our era.

WE learn from *L'electricite* that the American messenger telegraph will be introduced shortly into France.

THE TELEPHONE.—Count du Moncel thinks that a thick diaphragm in the telephone acts with difficulty because its magnetisation and demagnetisation takes place more slowly, and that a thin diaphragm acts better, not because its smaller mass enables it to vibrate more rapidly, but because it can be magnetised and demagnetised more quickly. The fact elicited by Professor Hughes, that a diaphragm built up of a number of thin plates laid one over the other reproduces the sound in a clearer and louder manner than a single disc, would seem to support this view.

A PLEA recently put by Mr. Elisha Gray before the French Academy of Sciences, to the effect that he was the true inventor of the articulating telephone, and not Professor Bell, was met by the statement that the Academy did not consider it their function to judge the question.

THE MICROPHONE.—Articulate sounds are better reproduced by fine metalised charcoal than by gas coke, while, on the other hand, simple sounds, such as the tick of a watch, are better heard by the latter.

THE possibility of yet being able by means of the microphone to tap the brain of its thought, is a startling idea entertained by Professor Hughes. He reasons that all thought is accompanied by an unconscious action of the articulating organs; we think in words and dream in languages, French when we are living in France, and German when in Germany, and therefore it may come to pass that by a highly sensitive microphone of the future the articulate vibrations of the head will be made audible. Many counter reasons can be urged against this theory; it might be pointed out that the lower animals evidently think without speech at all, that men think when their articulating organs are paralysed or fixed, that articulation is a slow process compared with the flash of thought, that memory and imagination dwell upon scenes without the effort of expression, and that dual thinking is a fact; but, nevertheless, Professor Hughes' notion is an interesting and debatable one. We have learned by the microphone to hearken to the clash of atoms; will it yet be in our power to listen to the working of the brain mechanism and hear the evolution of thought? We doubt.

THE PHONOGRAPH.—In the *Voyages Fantastique de Cyrano de Bergerac* recently republished by the *Librairie des Bibliophiles*, there is a tale entitled, "*Histoire Comique des Etat de la Lune*," which contains an account of a mechanical book which uttered what it had to tell like the phonograph. Cyrano de Bergerac was a kind of Jules Verne who flourished two centuries ago.

THE *Scientific American* for August 24, gives a detailed description with drawings of a simple and inexpensive phonograph which can be made by amateurs. It consists of a straight rod or square of wood run with two parallel V grooves along its face; and a mouthpiece with diaphragm, and spring point, constructed to glide along the rod by means of guides cut in the frame of the mouthpiece in such a position that the probe is over the grooves. A strip of tinfoil is smoothly lapped over the rod and held by bees'-wax. On moving the mouthpiece by hand along the rod and speaking into it the record is taken, and can be similarly reproduced.

THE ELECTRIC LIGHT.—It is stated in the *World* that Mr. Hollingshead attempted to bring Jablochkoff's electric candle to England, before he resorted to M. Lontin, but that Jablochkoff demanded no less than £350,000 for his English patent rights. Mr. Hollingshead did not happen to have that sum handy by him at the time, and so he fell back on the more modest terms of Lontin, whose light is now exhibited nightly at the Gaiety Theatre. Mr. Hollingshead deserves praise for the energy he has shown in establishing the electric light in our midst in spite of many obstacles. The "enterprising impresario" has at last brought out a "star."

THE Australian Intercolonial Telegraph Conference have accepted Col. Glover's terms on behalf of the Eastern Extension Telegraph Company, and a duplicate cable will now be laid between Singapore, Banjoewangie, and Port Darwin. A subsidy not exceeding £32,400 per annum will be payable by the colonies for a period

not exceeding twenty years. These cables will skirt the coast of Java, and thus dispense with the land lines, on which many errors at present occur from the Dutch operators knowing English imperfectly. The new cables will be protected by a complete copper envelope to exclude the marine insects which at present infest the existing cables, and are said to cause the interruptions which have been so prevalent of late.

THE American Chemical Society propose to celebrate the centennial birthdays of Humphry Davy and Gay-Lussac, which occur on the 17th and 6th of December, 1778, respectively.

MR. EDISON has been employed to devise some means of lessening the noise on the elevated railways of New York. These railways are carried along the thoroughfares of the city on iron girders and trestles over the head of the passenger traffic; and what with the clanking of the wheels on the rails, and the humming of the vibrating rods and braces, the din is said to be very disagreeable. The action of the railway company in employing Mr. Edison has been taken under the pressure of a petition signed by a large number of medical men who charge the nuisance in question with producing irritation, hysteria, and even dementia in persons residing within reach of the noise. Mr. Edison has been engaged in analysing the sounds b the phonograph and phonautograph.

EDISON has invented a machine for condensing the noise of the elevated railways in New York, running it down a pipe to the Battery, loading it on the Sound steamboats, and dumping it near Rattleborough, Vt. Great man, that Edison! The Rattleborough people expect to can the noise and sell it for Fourth of July celebrations.—*Phil. Bulletin*, U.S.

WE are glad to learn from the *Journal of the Telegraph*, U.S., that Mr. Frank L. Pope, of the Western Union Telegraph Company, and Mr. C. H. Haskins, Gen. Sup., of the North Western Telegraph Company, have arrived safely in the *Queen*, at New York. These gentlemen express themselves as highly pleased with their reception abroad, and desire our contemporary to return their sincere thanks to those who received and entertained them so kindly, and whose courtesy they will ever hold in pleasant recollection. There is nothing which tends so much to that most desirable thing—a mutually friendly spirit amongst the electricians of Great Britain and America—as these reciprocal visits paid by eminent members of the fraternity. Sometimes we journals of the craft, on both sides of the Atlantic, have occasion to use banter, and even ridicule, but it is done for the sake of piquancy and amusement, or for wholesome correction, and not at all from ill feeling. Any casual freak of that kind is but the play of light on the fretted surface of a stream of deep and cordial good fellowship, which will never fail, we trust, in showing itself to members of our common profession when they come among us personally.

THE American *Popular Science Monthly* for August (D. Appleton and Co., Broadway, New York; London Trübner & Co., Ludgate Hill), contains an interesting article on the Teredo and its depredations in submarine cables. There is also a sketch and excellent portrait of of Mr. T. A. Edison.

THE Continental Telegraph Company, U.S., is expected to begin public business between New York and Philadelphia on or about September 1st.

MDLLE. DODU, a young telegraph operator, who distinguished herself during the Franco-German war by an act of courage and devotion, has been decorated with the Cross of the Legion of Honour. Shut up in a chamber through which the telegraph wires conveying despatches to the German Army passed, she destroyed the connection at the risk of her life.—*The Continental Gazette*.

WE have received from the Director-General of Italian Telegraphs, Rome, a large and finely executed chart of the government telegraph lines in Italy, which has just been published by the Administration.

WE have also received a specimen sheet of the *Ronald's Catalogue*, from Mr. A. J. Frost, librarian to the Society of Telegraph Engineers. This catalogue, which contains more than 12,000 entries, will probably extend to over 600 pages, and is believed to include every important work and almost every paper which has been published upon the subject of electricity and magnetism up to the date of the author's death in 1873. It also forms a valuable catalogue of scientific works generally. Sir Francis Ronalds devoted the greater part of his lifetime to its compilation and in the formation of the valuable library now in the society's possession. The price of the catalogue will be 16s., and for a special librarian's form proposed, printed on one side only, 20s.

WE learn from *Engineering* that a torpedo corps has been formed for New South Wales, under Major Cracknell, the chief electrician of the colony. The torpedos employed by the corps are sunk in the waters of Sydney and connected by submarine cables to the harbour stations.

CAPT. TRERE, of the French Navy, has invented an electric brake by which the speed of a ship's engines may be controlled by touching a button in the cabin or on the quarter deck.

M. COPERO, Director of the French Postal Telegraph Department, proposes to tax each commune receiving weather reports, at the rate of £4 yearly. This step has evoked much discontent and will probably be withdrawn.

ATMOSPHERIC ELECTRICITY AND PLANT LIFE.—According to M. Grandeau, atmospheric electricity is a powerful agent in the process of assimilation amongst vegetables. He says that plants defended from its influence have built up fifty or sixty per cent. less of living (azotic) matter than those exposed to ordinary conditions. The proportion of ash is higher, and that of water lower, in plants sheltered from the action of atmospheric electricity. The electric screen enclosing the plants experimented on was formed of four triangles of iron The plants were maize, tobacco and wheat; all other conditions were the same, but of the two specimens pitted against each other one was screened from atmospheric electricity and the other was not. The plants after being allowed to grow for several months, were then measured, weighed and analysed. All the experiments exemplify the above percentage in the most striking manner. The plants tested are tall, but low growing plants are equally influenced by atmospheric electricity. This fact may help to explain the absence of herbs under certain trees. It should also be mentioned that the total development of the plant is proportional to that of the azotic matter, as in growth, under normal conditions. M. Berthelot, in a subsequent note to the Academy on this subject, draws attention to the discovery made by him that free nitrogen united itself to organic matter under the action of electric currents not only from ordinary induction coils, but from feeble voltaic batteries; for example, five Leclanché cells: the proportion of nitrogen thus fixed in seven months on paper and dextrine being 1·92 thousandths, which will represent about 1·2 hundredths of matter analogous to the nitrogenised compounds of vegetables. It would thus appear that the slow, continuous action of feeble atmospheric currents on vegetation has a far more important bearing on agriculture than the formation of nitrous and nitric acid with their ammoniacal salts by the violence of the lightning flash.

M. GRANDEAU, in a subsequent note to the French Academy, has supplemented the results given in the last note. By aid of a Thomson quadrant electrometer and water-dropping collector, he has measured the electrification under and in the neighbourhood of those large sheltering trees and bushes which appear to impoverish the soil beneath them. He finds that the potential beneath these trees is *nil*, while there is a sensible positive potential beyond the area which their foliage shelters These experiments of M. Grandeau show that it is not want of moisture, light, or heat alone, but want of electricity also, which renders the shade of dense trees so inimical to herbs and undergrowth.

ELECTRICITY AND GARDENING.—Prof. J. Macagno finds that in grape growing a decrease of the intensity of the available light hinders the formation of sugar; and that the formation of other products of assimilation is directly proportionate to the intensity of the light.

Perhaps the time is not far distant when the electric light will be used for forcing rare fruits and flowers during our dark winters, as much as artificial heat is now.

THE experiments of M. Grandeau described in the above note, also point to a time when the atmosphere of a forcing house may be advantageously charged with electricity as it is now charged with heat. The nature of iron conservatories and vineries tends to act as a screen to atmospheric electricity, and there is, therefore, all the more reason that electricity should be artificially supplied.

A NEW SINGLE FLUID CELL.—Mr. Pulvermacher has invented a novel form of element in which the atmospheric air acts as a depolariser. The exciting liquid (dilute sulphuric acid, caustic potash, or salammoniac) is placed in a porous cylindrical pot. Into this is plunged a rod of amalgamated zinc as a negative pole; while the positive pole is formed of a long curl of fine platinum or silver wire rolled round the pot. The spires of this wire are sufficiently wide apart to avoid capillary action and as they enwrap the pot they come in contact at an infinite number of points with the liquid which exudes from it. It is at all these numerous points of contact that the air exercises its oxidising action and effects depolarisation. The battery can be charged with liquid and discharged again by turning a tap. If zinc and liquid be supplied it will last indefinitely, because the air is always at hand. The electro-motive force of a cell charged with caustic potash solution is about 1½ volts on an average; with pure sulphuric acid diluted with 9 parts of water the electro-motive force is 1·16 volts. With a cell having a silver wire, a porous pot of good quality, 14 centimetres high, and 35 millimetres in diameter, the resistance was only 1·3 ohms. To give some idea of polarisation it should be mentioned that when the circuit was closed by a shunt of 10 ohms during 10 minutes, the electro-motive force diminished about 16 per cent., and it returned to its original value after the circuit had been opened three minutes.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In Mr. W. Dennett's paper on "A Single Current Duplex Translator" in the TELEGRAPHIC JOURNAL for 15th July, 1878, the expression "compensation current" is ambiguous. Compensation currents were used in some of the original duplex systems, but I believe they are generally discarded now. The current from battery B divides between the two coils of differential relay E. If the "down" station is sending at the same time the current in the outer coil (connected to line) is neutralised, and consequently the current in the inner coil (joined to rheostat) preponderates and therefore actuates the relay tongue.

In the sketch I observe that the copper pole of battery A, and the zinc pole of battery B, are connected to earth. I think the zinc poles of both batteries

should be to earth. If not, perhaps Mr. Dennett will kindly explain why.

The second relay, or automatic key, appears to me unnecessary, as the sounder can be made to answer the same purpose by placing it directly between the tongue and the working contact of the differential relay, connecting armature of sounder to terminal B, and the standard on which it falls, when attracted, to terminal F of the switch.

In single working battery A is used for "down" and battery B for "up" line, but in translation, battery B is used for "down" line. Unless the resistance of the two sections is the same the battery must be unsuitable in one case.

By joining permanently terminal B of one switch to terminal C of the other, and removing the connection between terminals B and C of each switch, the proper battery power for translation would be obtained.

I am, sir,
Yours truly,
H. A. W. FANSHAWE,
September 2nd, 1878. Indian Telegraphs.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In your issue of July 1st, 1878, in commenting on the claims of Professor Thomson and myself to the invention of the Telephone Relay, as contained in a short note to *Nature*, of June 20th, you remark that the application of the microphone to this purpose was pointed out by Professor Hughes at the meeting of the Physical Society, on June 17th. Your writer could scarcely have noticed that the note in *Nature*, on which his remarks were based, was dated Philadelphia, June 7th, as that date would clearly anticipate the application suggested by Professor Hughes.

Professor Thomson and myself exhibited a successful working model of an invention, at the Franklin Institute and elsewhere, on June 4th, accounts of which were published in the papers of this city on the following day.

Respectfully yours.
EDWIN J. HOUSTON.
Central High School,
Philadelphia, August 22nd, 1878.

[In our note of July 1st we had no intention to deprive Professors Houston and Thomson of the merit of this application, but merely to point out that such an application had been already suggested in England. Even if these gentlemen had not actually done the thing before Professor Hughes suggested it, the credit of performance would still have been theirs.—Ed. T. J.]

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—In your issue of 1st inst., I notice Professor Hughes has employed the microphone to settle the controversy between Colonel Navez of Belgium, and Count du Moncel, respecting the explanation of the physical action of the articulating telephone.

Having had perhaps as many facilities for experimenting in this direction, and those experiments having had their origin in the years 1869 and 1870; and having been continued up to the present time, it may be interesting to your readers to know that I have arrived at precisely similar conclusions to Professor Hughes in respect to the production of sound in the magnetised core. These conclusions had, in the first instance, been derived from experiments with alternating currents from a secondary coil, the make and break being a tuning fork similar to those employed by my brother Cromwell in his Harmonic Telegraph, patented in 1870.

Using then these currents, almost all descriptions of rheotomes will produce harmonic sounds, some feeble, others more intense; of the feeble class may be placed first the iron rod surrounded by a coil similar to Riess's receiver.

The second form is that of an iron hollow cone or funnel, in the spout of which is placed a bar magnet, the wire or coil being wrapped on the outside.

The third is an iron tube placed in a coil, in which is inserted the poles of two bar magnets, the north and south poles approaching to within an inch, so that the central part of the hollow core is highly magnetised.

This latter form gives articulate sound from a microphone sender. It may be urged that in the experiment described by Prof. Hughes the bar magnet resting on the top of the coil shown in fig. 1, page 361 (TELEGRAPHIC JOURNAL), is, after all, a modification of the vibratory plate of the Bell telephone, that the alternation in the current flowing through the coil would set the bar in vibration, and those vibrations being communicated to the resonating sounding board, become augmented and easily audible. But it will be seen that the hollow iron tube is free from this objection. The sound being produced between (if I may use the term) the current flowing through the coil and the magnetism in the core, so that when the relations between them are disturbed a sonorous vibration is the result.

I have succeeded in constructing a receiver which depends entirely on the magnetised core as the source of power, independently of the vibratory plate used in the Bell telephone. It gives very clear sounds, and will answer to either the currents conveyed by the microphone sender or from a Bell telephone. These results I hope to be able to make the subject of a communication to one of the societies, where diagrams and experiments will explain more clearly the methods employed and the results obtained than I can possibly do by this letter. I have likewise been examining the action of the microphone, and shortly I shall give details of experiments which will subvert Prof. Hughes' theory of molecular contact and vibration as clearly as his experiments have assisted the labours of the Count du Moncel, who has helped considerably in throwing much light on this, at present, imperfectly known action of the articulate telephone.

I am, dear Sir, yours very truly,
FREDK. H. VARLEY.
Sept. 10, 1878.

J. J. FAHIE.—Many thanks for your letter. Your suggestions are good, and we will certainly bear them in mind. No. 125, TELEGRAPHIC JOURNAL we sent as you requested.

THE ELECTRIC LIGHT AT SEA.

The following interesting letter has been received by Messrs. Siemens Brothers:—

S.S. "Faraday,"
London, August 11th, 1878.

DEAR SIRS,—During our last voyage homeward from New York, we had a proof of the utility of the electric light on board ship.

On the night of the 18th July, near the Georges Bank, we narrowly escaped collision with a large full-rigged ship, under the following circumstances:—

About 10.30 p.m., wind fresh from westward, fog very dense. Suddenly we heard the sound of a bell ringing furiously, at a short distance nearly ahead. We immediately stopped our engines, and, supposing it to be a fisherman at anchor or almost stationary, I ordered the wheel to be ported; at the same moment the electric light pierced the fog, and plainly showed the head sails of a ship heading to the southward and crossing the bow. Not a moment to be lost, we shifted the wheel to starboard, put the port engines full speed astern, and starboard engines full speed ahead, and cleared her by

a few feet only. Our look-out men say they could have stepped on her stern.

She appeared to be full of passengers, and the cries of women and children were heartrending. I never shall forget it. I hailed them several times, telling them they were safe; but it was no easy matter to get them to realise it, seeing death, as it were, staring them in the face.

Of course they could see nothing but our powerful light, whereas we could plainly see people and everything on board the other ship. Had I not been able to see her so plainly, and the way she was going, we must have gone over her, or she might have struck us on the port bow: in either case the loss of life must have been great, and even now it seems terrible to contemplate.

In this particular case we are more than a thousand times compensated for the trouble and expense in fitting our electric light, and I wish all other steamship owners would adopt it as a means of safety in navigation: for, I believe, when the reflectors are properly adjusted, that the land as well as ships may be seen on a dark night in time to avoid danger.

I am, dear Sirs,
Yours faithfully,
(Signed) SAM. TROTT.

General Science Columns.

Results of the Solar Eclipse.—The most striking fact about the recent solar eclipse was the greatly diminished brightness of the corona as compared with the eclipse of 1871. That eclipse took place during one of the sunspot periods, or times of great solar activity, accompanied by a large red corona, many spots and prominences, magnetic storms, auroræ, and earth currents, as well as heavy rainfall and freedom from famines. This present year there are few or no spots, the prominences are much rarer, the magnets are undisturbed, there are no aurora, and it may also be noted that there are no famines. This year also the corona is small and white. In 1871 the continuous spectrum of the corona contained a great number of brighter lines, caused by irruptions of glowing gas bursting into the sun's upper atmosphere, and indicating an intense energy of heat. This year those bright lines are absent, showing that the solar energy is lessened; a fact borne out by the decrease of solar radiation to the earth this year. The continuous spectrum, which is due to solid or liquid bodies, shows by its want of bright lines that the cooler envelope has settled down closer on the sun and that there is waning of its internal energy. These solid and liquid particles are supposed to be meteoric bodies. According to one measurement, the cromosphere was found to be 2,000 miles in thickness. The upper and lower portions of the sun were graced by exquisite tracery, bending over right and left like plumes of ostrich feathers, the intervals between being of a delicate blue. The structure of the corona was distinctly less filamental than before. Prof. Cleveland Abbe, prostrated by weakness at a point midway up Pikes' Peak, had the rare fortune to note, with the naked eye, the singular appearances of the streamers, which are a luminous haze, extending far beyond the corona. As seen by some, it resembled a wind vane in shape, the black disc of the sun occupying its middle and the three corners projecting beyond, its general direction being that of the ecliptic. Prof. Abbe likened it to two triangles crossed at right angles with the moon's disc, in the middle region common to both; thus giving streamers nearly at right angles to the ecliptic, a result totally unexpected but now beyond doubt. Prof. Abbe attributes these streamers, which extend to five or six solar diameters from the sun, to meteor streams, while Prof. Newcome regards this matter as causing the zodiacal light.

The dark lines observed in the coronal spectrum and the evidence of polarisation of the sun's light received, endorse the belief that the coronal light is due partly to true solar light reflected to us by the molecules of corona, as it reaches them. Professor Hastings declares the polarisation to be tangential, a result which can only be explained according to our present knowledge, on the amusing supposition of *ice crystals in the sun's atmosphere.*

Professors Watson and Swift have signalled an intra-mercurial planet which may turn out to be the suspected Vulcan planet of Leverrier.

The black shadow of the moon, its rim fringed by a coloured iris or spectrum, as seen from the summit of Pikes Peak, cleaving its way along the lower air was a most striking sight, and appeared solid enough to sweep everything before it. On the wide expanse of the Alkali Plains round Separation and Preston—plains broken by no object save the wonderful avenue of telegraph poles along the railway, and the solitary water tank and telegraph operator's house, all was clad in a weird and leaden light. The fall of temperature during the eclipse at some of the most southerly stations was about 20° Fah. Edison's tasimeter showed distinctly the passage of the slit of the telescope to which it was attached from the dark disc of the moon to the image of the corona. Not giving quantitative results, however, it was of no service, and Professor Young resorted to a thermo-electric pile, with which he discovered a heat line in the ultra red, a result which opens out another new field for future eclipses. On the whole the last eclipse has been a most successful one, and not the least of its success is the eagerness to which it has given rise among astronomers to behold the next.

A New Metal.—M. Lawrence Smith announced the discovery of a new metal, which he has called "Mosandrum." It is found in the mosandria earth, a mineral belonging to the gadolinite family, and is analogous in its properties to cerium and terbium. This "new" metal has since been proved to be terbium.

Articulation.—We make the following quotation from an exhaustive and excellent paper on "Speaking Machines," in *Good Words* for July:—"Articulate sounds we all know can be separated into two elements, vowels

and consonants, the former being the groundwork of the latter, or, as Max Müller remarks, 'consonants fall under the category of noises,' due to the working of the mechanism producing them. The pure vowels are produced by a continuous expiration, the mouth being kept open, but the size of its cavity varied by altering the position of the lips and palate. The vibration of the vocal chords yield an indiscriminate mixture of sounds—a compound tone; the mouth forms a resonant chamber, like a cave; and by adjusting the size of this chamber certain elements of the compound tone are strengthened to the exclusion of the rest; just as the sound of a Jew's harp, when held between the teeth, is intensified by the resonance of the mouth, and modified by the size we permit our tongue to give the cavity. These changes can be recognised if we pronounce successively *e* (as in he), *a* (as in hay), *o* (as in oh), *oo* (as in cool).

"The theory of vowel sounds was first enunciated by Wheatstone, and confirmed by the experiments of Donders, whilst the classical researches of Helmholtz, leave but little doubt as to the origin of these sounds. Helmholtz, in fact, has not only dissected the vowel sounds, and discovered their constituent elementary tones, but he has put together these elementary tones yielded by different tuning forks, and so built up the entire series of vowels by mechanical means.

"Certain consonants, as *h*, *s*, *l*, *r*, &c., may also be produced by continuous currents of air, modified by the tongue and lips. Other consonants, such as *m* and *n*, or *b* and *p*, &c., can only be produced by momentarily stopping the current of air, and commencing or finishing the vowels by a kind of explosion, thus, *ba*, *at*, *me*, &c.

"It is possible to make a rough imitation of the larynx by simply rolling a sheet of foolscap into a narrow tube, and over one end, tying side by side, a couple of strips of thin india-rubber; on blowing through the tube a musical note is obtained, which can be varied in pitch by squeezing the tube, and so altering the tension of the india-rubber vocal cords. Nay, more, when speech has been lost by disease or removal of the natural vocal chords, artificial ones, formed of a vibrating tongue, or 'reed' of metal or ivory, have been made, and inserted in the larynx of the sufferer, restoring to him at once the power of speech. In fact, so successful is this artificial substitute, that the only difference noticeable, appears to be the peculiar monotone of the speaker; who, however, has the advantage of having a variety of voices at command, for by selecting a grave 'reed,' to-day, he can roar like Bottom, the weaver, and by using a high pitch to-morrow, speak with the shrillness of a shrew."

TURKEY in Asia embracing within itself the temperature of every climate, and enjoying a fertile soil, is capable of producing the products of every climate. As it is, cereals of every kind are found in abundance. Cotton, where cultivated, has proved very successful. Silk is furnished with facility in an extensive region starting from Diarbekir and going down to the Black Sea. Opium, rice, gall nuts, many varieties of dyeing woods, and many other products of agriculture are cultivated in quantities which more than meet the demands of commerce as it exists, and yet not one quarter of the land capable of producing is under cultivation. Extensive forests of oak, pine, beech, ash, cedar, walnut, and chestnut now grow but to rot away. The mineral wealth of the land is, so to speak, untouched, though known to be abundant. The only metal extracted from the earth is copper; yet lead, silver, iron, coal, and mercury are known to exist in abundance. It can be truly said of Asiatic Turkey that its impoverished population treads in its misery on gold.

CYPRUS.—The vines are richer than in any other country, and, when properly cultivated, will supply us with the wine Homer praised so much. Throughout Turkey in Europe it is used as a cure for consumption, and the Americans have of late been drawing large supplies of it. Aromatic tobacco of the most delicate quality is extensively grown, principally for the St. Petersburg market. Fine hard timber is plentiful, notwithstanding the enormous quantities that have been recklessly cut down by the Government, and a Turin firm are now exhibiting some rare specimens in Paris; sleepers for railway and other purposes will be found in abundance, especially when the existing roads are repaired and others constructed; rice, beans, wheat, barley, olives, raisins, locust-beans, cotton, hemp, wool, silk, beeswax, honey, madder, and beet-root are extensively exported. The mines are rich in copper, and a proof of gold existing is that large pieces of the precious metal are daily washed down by the mountain streams; capitalists will find the mines, once worked by the Greeks and others, but now abandoned, a source of unlimited wealth. Coal is also found, but, through lack of enterprize, the mines have never been touched; mineral and lake salt is abundant, and ozokerit exists not far from Leucosia, also at Citti.

DREDGING IN THE GULF OF MEXICO.—We are indebted to *Nature* for the following facts, derived from the dredging operations of the U.S. steamer *Blake*, in the Mexican Gulf, between Yacatan and Florida. The great Alacran reef is an atol—an atol existing, not as Darwin suggests to be the case with atols in general, in an area of depression, but in one of elevation, like those in which the Florida and Bahamas reefs are found. The formation of the Alacran reef is in full activity. The eastern slope is nearly perpendicular, rising to a height of twenty fathoms from the surface, in a comparatively short distance. It is exposed to the full force of the north east trades, and the surf breaks heavily against the great masses of *Madrepora palmata*, which build up the narrow line of coral barely flush with the level of the sea. Along the Cuban coast the dredge

brought up immense numbers of silicious sponges, a species of Favosites, which is perhaps the most interesting coral ever dredged. Amongst the strange fish brought up by the dredge, which worked well to a depth of 2,000 fathoms, there was a huge tadpole, with a gigantic round cartilaginous head, and without eyes; and of another with a drawn-out, flat head, very little eyes, but possessed of gigantic filaments, as long as the whole body. A steel galvanised wire and hemp rope 1½ inch in circumference, was used with the dredge, It weighed 1 lb. to the fathom, had a breaking strain of over 8,600 lbs., and sank by its own weight. The time required to reel in was always under a minute per 100 fathoms, while the time required to sink averaged 35 to 45 seconds per 100 fathoms in the deepest soundings.

City Notes.

Old Broad Street, September 13, 1878.

The report of the Directors of the Direct Spanish Telegraph Company for the half-year ending 30th June last, state, that owing to the continued depression in the Spanish trade, the net profits for that period amount to only £3,411 16s. 8d. The dividend on the preference shares, payable on October 1st, will absorb £2,921 10s., and leave a sum of £490 6s. 8d., which, with a small further amount, would be sufficient to pay the arrears of 1s. 9d. per share still outstanding on the preference shares. The directors recommend the withdrawal of this further amount (£20 18s. 7d.) from the reserve fund. The reserve fund at present stands at only £1,097 9s. 4d. Hopeful signs of a revival of business with Spain are mentioned, they being particularly noticeable in the iron districts around Bilbao, where greater activity, it is said, prevails than has been the case for several years past. Sincerely we hope the Direct Spanish Telegraph Company may have a more successful time before it. The cables of the company, the report states, are in the same high electrical condition as at the time of the last report.

Since our last issue the Eastern Extension Company have notified the temporary interruption of their Singapore-Batavia Cable for repairs; communication has now been re-established.

The Amoy-Shanghai Cable has also been interrupted and restored.

Mr. Abbott in his last monthly list says nothing respecting telegraph property; he, however, refers to the recent depression in gas shares owing to the interest now being manifested in the electric light, and remarks that "it cannot be ignored that there is at last a slow awakening to the fact that we are on the eve of a great revolution in the lighting of our cities and towns."

The following are the late quotations of telegraphs:—Anglo-American, Limited, 60¾-61¼; Ditto, Preferred, 90-91; Ditto, Deferred, 34-34½; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6⅝-6⅞; Cuba, Limited, 9½-10; Cuba, Limited, 10 per cent. Preference, 15¾-16¼; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 9½-10; Direct United States Cable, Limited, 1877, 13-13½; Eastern, Limited, 7¼-7½; Eastern, 6 per cent. Debentures repayable October 1883, 106-109; Eastern 5 per cent. Debentures repayable August, 1887, 99-101; Eastern 6 per cent. Preference, 11½-11¾; Eastern Extension, Australasian and China, Limited, 7⅜-7⅝; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-108; German Union Telegraph and Trust, 8-8½; Globe Telegraph and Trust, Limited, 5¼-5⅜; Globe 6 per cent. Preference, 10⅞-11⅛; Great Northern, 8-8½; Indo-European, Limited, 20½-21½; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 9½-10; Reuter's Limited, 10-11; Submarine, 217-222; Submarine Scrip, 2-2¼; West India and Panama, Limited, 2-2½; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited, 3¾-4¼; Ditto, 6 per cent. Debentures "A," 93-96, Ditto, ditto, ditto, "B," 91-93; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds; 114-118; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 30½-31; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅝-2¾; India-Rubber and Gutta-Percha and Telegraph Works, Limited 30-31.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£ *	£	£	£	£	£	£	£ ‡	£	£ ♭	£ *
August, 1878 ...	43,720	11,244	2,700 †	878	14,560	35,889	24,870	18,413	... ...	10,151	... ...	... ...	4,336
August, 1877 ...	41,170	9,513	2,729	790	15,700	40,428	25,371	17,998	... ...	9,683	2,025	7,790	4,200
Increase	2,550	1,731	... ...	88	... ...	... ...	... ...	415	... ...	468	... ...	... ...	136
Decrease	... ...	... ...	29	...	1,140	4,539	501	... ...	... ...	... ...	... ...	... ...	... ...

* Estimated. † June Traffics realised £3,177. ‡ July Traffics were £2,250. ♭ Not published.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).

THE TELEGRAPHIC JOURNAL.
VOL. VI.—No. 136.

THE OUTLOOK OF ELECTRICITY.

IT has often been remarked that of all the sciences there is none which has been of more vigorous and rapid development than electricity. Long hidden in the dark womb of nature, like a spellbound genie, or a faculty asleep in the soul, it has within these latter generations sprung into quick existence, growing like a giant, and doing a giant's work. With all its practical power there is a brilliancy about its marvellous effects, which renders it a most fascinating pursuit, the most fascinating science of all perhaps. And this very shining quality has had an untold effect in furthering its own increase. The minds of men, however philosophical they may be, are ever fascinated by the miraculous and lured by beauty. What wonder then that electricity, whose effects are so beautiful, and withal so miraculous that to the uninitiated they seem to be creations of the magician, should number among its admirers and votaries all kinds and conditions of men. It has been said that a science progresses by the compound interest law, but electricity, at least, is an exception to this rule. The recent burst of electric invention, indeed, points to a more complex order of development than can be expressed by any known formula. Human genius, an altogether incalculable thing, must be taken into account in science, even as it is taken into account in poetry. The telephone and the microphone are pregnant factors in the advance of electrical science, corresponding to cataclysms in the uniform process of evolution. They have of late carried the science forward by a jump, and it is natural now to pause and view the outlook ahead.

The Victorian era will be ever memorable in history as the nurse of the steam-engine, of gas lighting, and of the electric telegraph. But it does not require a prophetic eye to foresee the time when electricity will supersede both gas and steam. Man uses first those resources of nature which are nearest to him, then seeks out and utilises those which lie deeper. He hunts the wild animal crossing his path, then herds it on the grass, then tills the surface soil, then digs up coal and metals from the bowels of the earth, and at last when these palpable resources begin to fail his hand and sense, he looks into the secret store-room of matter with the eye of intellect, and discovers new mines of power even richer than the old. At present we are consuming one hundred and fifty million tons of coal per annum, and this waste cannot go on for ever. Our coal fields will inevitably become exhausted. But shall it then be necessary to buy our coal from other countries, say from our more prosperous "kin beyond the sea," as Mr. Gladstone poetically calls our American cousins, who doubtless in the shabby future which that fermenting patriot gratuitously depicts for his countrymen, will despise their impecunious relative and, at the same time, grow fat upon her poverty. Perhaps not. Perhaps the electro-motor will worthily replace the superannuated steam-engine; and the restless waves which ring our rocky coasts, the cascades which foam from our highland fells, will relieve us from the necessity of filling the Yankee purse, and carrying the wherewithal to keep us warm, and turn our mills, and lighten our darkness, over two thousand miles of stormy sea. The electric light is now fairly equipped as a formidable rival of coal gas. For large works and public squares, where a few light centres suffice, it is in every way superior to gas, at a smaller cost; and if it could be distributed with less loss of energy and at smaller expense, it would speedily take the place of gas for street lighting also. It is certain to become a dangerous competitor against coal gas, and unless the latter is improved in quality and reduced in cost, its employment will by no means be so universal as it is at present.

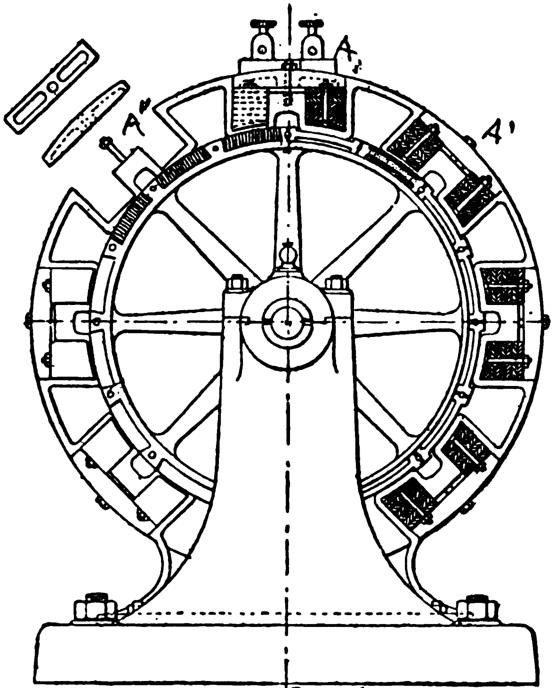
The possible applications of electricity are indeed, legion. Every day sees a new one. Its great mission is manifestly that of a vehicle of energy, and it appears to be capable of reproducing all modes of motion. If it is true that all the known forms of energy are mutually convertible, then electricity will probably be the practical channel of this transformation. We have seen during these latter years how magnetism, heat, and sound, can be transported into space by the electric current. In the future, near or remote, it will in all likelihood wing the shafts of light, and as men now hear by telegraph, so will they see. Nerve force is surely a form of physical energy too; and with the fair prospect which we have before us, it is hardly too daring an imagination to anticipate the time when sensation itself may be transformed into electricity, and pain and pleasure sent by wire.

THE MAGNETO-ELECTRIC MACHINE OF M. DE MÉRITENS.

By TH. DU MONCEL.

THE commercial and industrial field, opened up lately by the electric light given by magneto-electric induction machines, has led, on all sides, to researches and improvements which have considerably advanced the problem of electric lighting. Everyone now knows the beautiful machines which MM. Siemens, Gramme and Lontin con-

HALF ELEVATION A HALF SECTION.



B *Fig. 1*

Plan.

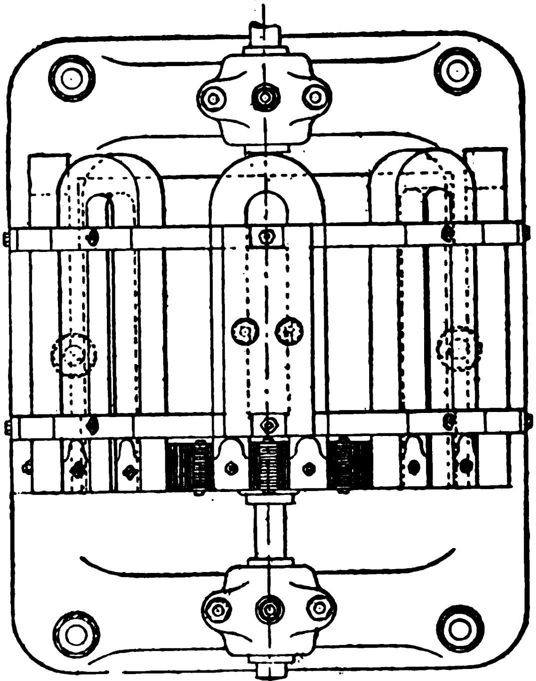


Fig. 3

SECTION A B.

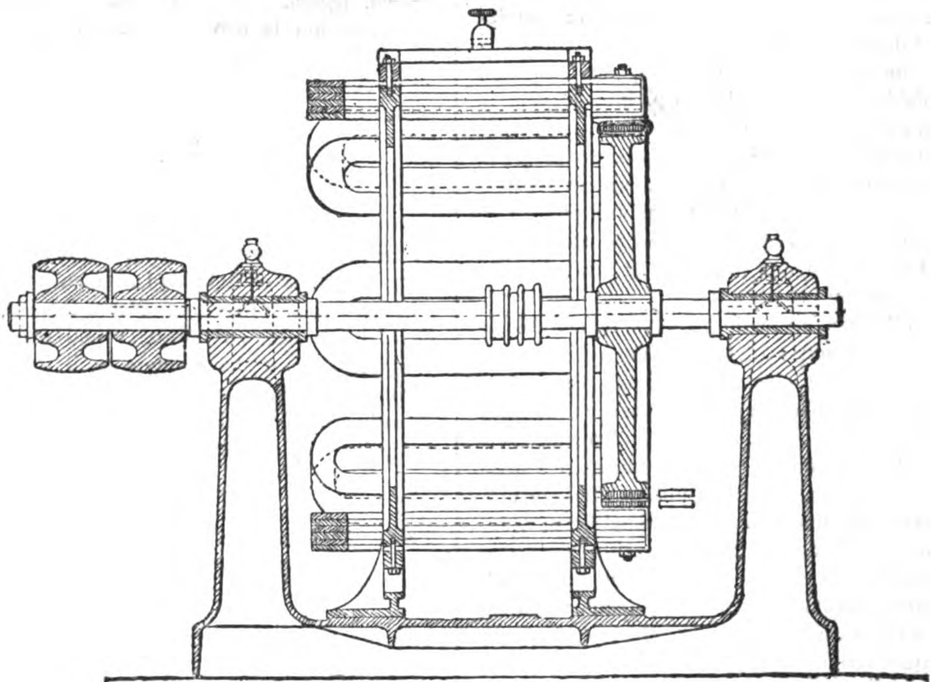
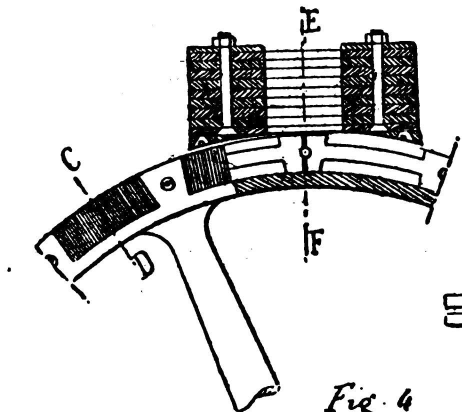
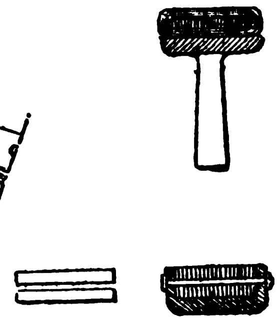


Fig. 2





SECTION E F (PLATES REMOVED).

Fig. 4

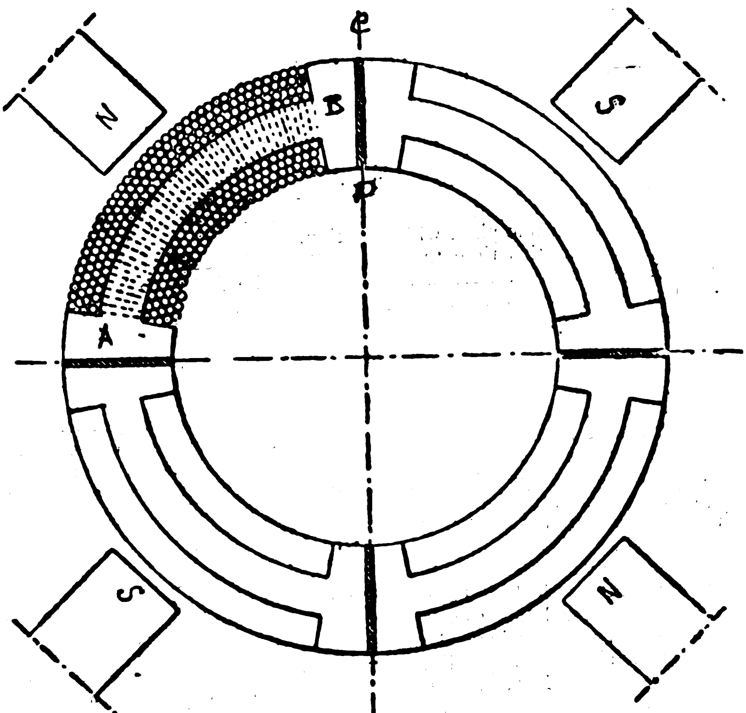


Fig. 5

DETAILS OF THE COILS AND MAGNET SECTION C D.

struct, and one might have thought on looking at them that it would be difficult to bring them to further perfection. However, we believe that the final solution of the problem is not yet attained, and it is probable we shall soon see something better. Already the machine just constructed by M. de Méritens is a considerable step taken in this direction, and I am justified in believing that this machine, which has already astonished those who have seen it at work, has not yet said its last word.

For us, who have from the outset watched the progress of these machines and who have ourselves contributed to the early improvements which were introduced into them, we regard with unfeigned pleasure the progress of this industry, which may be almost said to have been born in France. At the same time we must not forget that it is to the *Alliance* Company, and its clever engineer, M. J. Van Malderem, that we owe this magnificent application of electricity.

With this view, we think it will not be without interest to our readers to relate briefly the history of these machines.

In 1855, M. Nollet, a Belgian maker, constructed for electro-plating large magneto-electric machines on Clarke's system, which gave results of sufficient mportance to lead to the formation of a company who were to work them for the purpose of extracting gas from water. The idea was a foolish one, but for that very reason it found adherents, and it was this company which, under the name of the *Alliance* set up in 1855, in the buildings adjoining the Hotel des Invalides, the first large magneto-electric machines known in Europe.

Naturally the results were deplorable, and in 1856 the company was forced to liquidate.

It was re-organised later in 1856, and having appointed M. Berlioz its director, sought to avail themselves of some of the considerable plant which had been got together. It was at this time that I was consulted, and I pointed out to M. Berlioz the applications he could make of them to electric lighting and plating, but to this end many improvements had to be carried out in the machines, and every electrician of the period added a stone to the edifice.

Among these improvements, one suggested by M. Masson, who was at that time Professor of Physics at the Ecolé Càntràlé and whom I had brought to see the machines, permitted an immediate doubling of the effects attained. It was to do away with the commutator, which had hitherto been employed in all these machines. These various improvements, admirably interpreted by M. Van Malderem conjointly with those he himself introduced, brought these machines to a state of perfection which one could scarcely have dared hope for at the first and which it was firmly believed it would be impossible to surpass. It was then that the idea was formed of making use of them for illuminating lighthouses and ships; experiments were commenced conjointly with MM. Reynaud and Degrand, and soon after, in 1863, the lighthouses of La Héve were lighted up in this manner.

At the same time experiments were made with a view to its application to navigation, but they did not meet with the success that might have been desired, principally by reason of the opposition offered by the Navy, although they gave results the importance of which was afterwards appreciated. It was France who preceded other nations in these two directions, as it is she who still leads them in public lighting. But we must admit that it is to the Alliance Company and to the courageous initiative taken by its intelligent director, M. Berlioz, that the civilised world owes these beautiful applications of electricity.

Having paid this tribute to a company whose efforts were not seconded by fortune, let us examine the further progress accomplished in later times.

The Alliance machine was a magneto-electric one, that is to say, composed of permanent magnets and induction coils. In its latest form it employed forty-eight magnets and four rollers each provided with ten induction coils; it gave reverse currents, and could feed three Jablochkoff candles; it required about three horse-power to drive it, and ran at a speed of 400 revolutions per minute. No heating took place in the machine, and the light given by it was very regular.

Under quite exceptional conditions this performance has been much increased, and a machine has even been spoken of which could feed six candles; the ordinary machines are, however, far from giving such results. But the machine we are about to speak of can, with eight magnets only (magnets of the same size as those of the Alliance), illuminate from three to four Jablochkoff candles, and it also gives reverse currents, which are rightly regarded as a favourable element in public lighting. It is true that the speed of this machine is greater, for it performs 700 turns per minute; but I am assured that it requires a motive force of only seventy-eight kilogramme-metres, *i.e.*, rather more than one horse-power, and experiences scarcely any heating. Its dimensions are very small, and its elementary parts are easy of adjustment and simple in construction.

The enhanced effect of this class of machine is due to the fact that to the induction currents produced in the coil of the Gramme machines are added those produced in ordinary magneto-electric machines.

In order to understand this, let us imagine a Gramme ring, fig. 5 divided for example into four sections, insulated magnetically the one from the other, and forming, consequently four electro-magnets placed end to end; let us suppose that the iron core of each of these sections is terminated at each end by a piece of iron A B, forming expanded prolongations of the poles; and let us suppose all these pieces to be joined by pieces of copper C D, to form one solid ring, around which are placed permanent magnets N S, with the poles alternating with each other.

Let us examine what will take place when this ring accomplishes a revolution upon itself, and let us see in the first place, what will happen on the approximation of the expanded pole B, as it travels from left to right, to the pole N. At this moment it will develope in the electro-magnetic helix an induced current, as in the Clarke machine. This current will be instantaneous, and in a contrary direction to the Amperian currents in the inducing magnet. It will be very powerful by reason of the proximity of B to the pole N; but the ring in passing on causes a series of magnetic displacements

between the pole N and the core A B, which give rise to a series of currents, which I call currents of polar interversion, from B to A. These currents will be direct in relation to those in N, but they are not instantaneous, and they increase in energy from B to A.

To these currents will be joined simultaneously the currents (of dynamic induction) resulting from the passage of the helix before the pole N. When A leaves N a demagnetisation current is produced, equal in energy and in the same direction as the magnetisation current due to the approximation of B to N. Thus we get reverse induced currents through the approach and recession of B and A; direct induced currents during the passage of the core A B before the inductor; direct induced currents resulting from the passage of the helix in front of N. All these inductive effects are thus accumulated in this combination; * * * * there are also currents resulting from lateral reaction of A B upon neighbouring poles.

To still further augment the effects of induction, M. de Méritens makes the core and appendages of thin plates of iron cut out as seen in the figure, and placed together to the number of fifty, each one millimetre thick. The coils are so arranged that they can be connected for tension, quantity, or in series.

In fig. 5 we have considered only four sections, but there are in fact more than this, the model to which we have referred possessing sixteen as shown in fig. 1. They are mounted on a bronze wheel centred on the motor shaft.

The inductor magnets, the poles of which are seen at A A′, are placed above the wheel and strongly fixed horizontally to two bronze frames, as seen in figs. 2 and 3. A″ shows the method of adjustment.

A little consideration will show that the ring is constructed under the best possible conditions. In fact, as each section is separate it may be dismounted singly, and consequently the wire can be wound on without difficulty. Those who know the difficulty of winding a Gramme ring will readily appreciate this advantage; on the other hand the core being composed of plates which can be at once removed by releasing the key-piece is an enormous advantage, for it obviates the precision necessary to the construction of solid rings, which are always difficult to keep perfectly true. Lastly, there is neither commutator nor collector, and consequently no loss of current.

Figs. 2 and 3 represent a vertical section, and the details of construction, which will be understood without further description.

We have said that this machine can feed three or four Jablochkoff candles applied to an electric light regulator; but it has also been found competent to illuminate regulators, even when the carbons were separated by a distance of three and a half centimetres. It is certain that these results are very important, and one may safely augur a future for this machine. All who were present at the experiments were astounded.

These machines are ably constructed by MM. Chardin and Cerjot, assisted by M. Maurin.—*L'Electricité*.

[We are indebted to the editor of *L'Electricité* for the blocks wherewith to illustrate this article.—ED. T. J.]

NEW PORTABLE BATTERIES.

M. BEAUFILS' BATTERY:—A new feature, which is likely to be of considerable importance in the manufacture of batteries henceforth, has recently been introduced by M. Beaufils, a chemist of the French Telegraph Administration, Paris. It consists in forming the depolarising salt into a solid conglomerate, a form which has many advantages in point of portability, cleanliness, and economy. M. Beaufils has applied his idea of conglomerate depolarisers to the Marie-Davy sulphate mercury battery, and the result is a superior and very lasting portable pile, which cannot fail to be of great service in military and domestic as well as civic telegraphy. The larger forms of this battery are in use on the French Telegraph service, and have, we believe, given very good results. Figure 1 represents in full size, one of the smaller types, designed for medical purposes. It consists of a

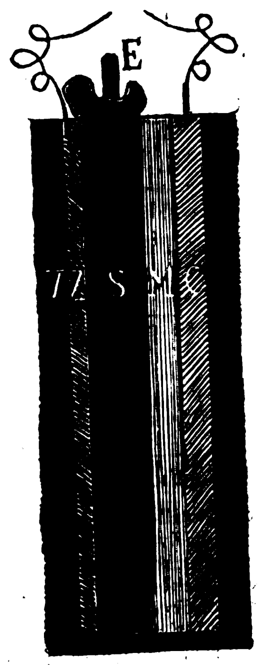


FIG. 1

vulcanite vessel V; a zinc plate Z; a carbon plate C, to which is attached a slab of powdered carbon and sulphate of mercury conglomerate. The conglomerate and zinc plate are separated by a piece of sponge S, wet with water. Electrodes are connected to the poles. To charge this cell, or any of the other forms of the conglomerate battery, it is only necessary to damp the sponge, or add clean water. One of these cells will work for years without any attendance. The electro-motive force is that of the Marie-Davy battery.

We may add that the makers of the Leclanché battery, recognising the importance of the conglomerate principle, have adopted it in the manufacture of the latest Leclanché cells.

M. GAIFFES' BATTERY:—Is a chloride of silver element designed for medical purposes. Fig. 2

represents the internal arrangement of the plates; Z is the zinc plate; S the silver plate, a paddle shaped slab of silver; and P is a bed of bibulous paper intervening between the zinc and silver plates; E is the cover of the cell, an ebonite top carrying the terminals; and R is a clasp of ebonite, or an india rubber band, to hold the plates together. In order to change the cell it is only necessary to moisten the bibulous paper with a solution of chloride of silver in water. The cap fits tight to the top of the vessel, which is also of ebonite, and thus prevents evaporation.

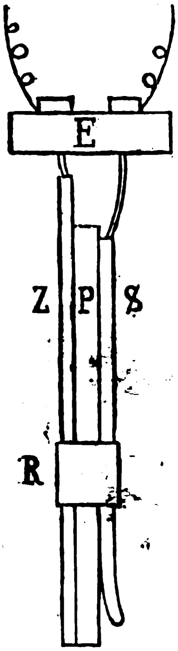


FIG. 2.

We have recently called attention to the advantages of the chloride of silver cell as a constant battery, especially for testing purposes, and we would now suggest that experiments should be made with a view to forming a solid conglomerate of the chloride of silver, on M. Beaufils' principle, so as to increase the portability and serviceableness of this cell.

THE RONALDS' LIBRARY AND CATALOGUE.

By ALFRED J. FROST, Acting Librarian of the Society of Telegraph Engineers.

AT the Conference of Librarians, held in London last year, the writer briefly called attention to the fact that the Society of Telegraph Engineers was preparing for publication a complete catalogue of the literature relating to electricity and magnetism, and the cognate sciences. The catalogue referred to (which has been edited by the writer) was compiled by the late Sir Francis Ronalds, F.R.S., who devoted the greater part of a long life to its completion, and to the formation of a valuable library bearing his name, now in the possession of the Society of Telegraph Engineers.

Sir Francis Ronalds, who became one of the earliest members of the Society, died in 1873, bequeathing the library to his brother-in-law, Samuel Carter, Esq.; and this gentleman, in accordance with the wishes of the testator that the library should be made available for students of electricity, handed the same over to the Society upon certain conditions, one being that the Society should bear the cost of printing the catalogue, which it had been the labour of its author's life to complete. The Society, although a very young one, willingly undertook the charge, and has spared no expense in making it worthy of its author, and of its importance in relation to science and bibliography.

The catalogue contains upwards of 12,000 entries, and is believed to contain a record of nearly all the important books and papers bearing on the subject, published in any language, up to within a short time of its author's death.

In the compilation of the catalogue, Sir Francis Ronalds adopted what is now known as the card system, thus using a separate slip for each entry. I am not aware who introduced this system, or the date of its introduction, but inasmuch as the catalogue referred to was commenced probably as early as 1820, I think Sir Francis Ronalds may be numbered amongst the earliest to see the advantages which that system bears over many others, especially in the compilation of a catalogue where many of the books are not seen, but have their titles, &c., copied from other sources. Every slip in the catalogue shows upon its face the whole history of the record. For example, in many instances it is found that the first notice of a work was obtained from some author's reference; later on—perhaps years—some further information is obtained of the work in, probably, an old bookseller's catalogue, the slip is looked up and the further particulars are added, the source of the information being given in every case; later on again, perhaps a further reference to the work is found in the catalogue of some public library, in which case any further information thus obtained is added to the slip, and lastly the book itself finds its way into the library, when all doubt as to accuracy of the entry is at an end, as the actual title is then examined with the slip, and any particulars which have been omitted are inserted. Another advanvantage of using a slip for each entry is the facility given for making notes. Had the titles been entered into a book it would have been very difficult, and almost impossible, to have added so much from time to time, as it was found necessary to do, in the work now referred to.

It was considered desirable to preserve as many of the author's notes and references as possible, and these notes will form quite a special feature in the catalogue, besides which there will be found after most of the important names a reference to the date and place of birth, and when possible the date and place of death of the author. Although this information is not usually given in printed catalogues, it was thought that it would not detract from its value, if inserted, but would, on the contrary, enhance its importance, and render the work more valuable as a book of reference.

The publishing committee of the society gave considerable attention to the type most suitable, and it was decided to adopt large Clarendon type for the authors names; all notes, references, &c., otherwise than the actual titles, being printed in italics; special prominence has been given to dates. The books actually in the library are designated with a dagger.

Although the catalogue professes to relate simply to electricity and magnetism and their applications, it will be found a most valuable record of scientific books generally, inasmuch as almost all books treating of Natural Philosophy and Physical Science, contains something electrical, and it was of course necessary to include all such books in a work of this nature.

The catalogue will be published at a price much less than its cost, and it is proposed to issue to subscribers a separate Librarians Edition, printed on one side of the paper only, the price of which will be 20s., the price of the catalogue in the ordinary form being fixed at 16s.

The library formed by Sir Francis Ronalds, above referred to, contains about 10,000 works, a large number of which consist of the electrical papers cut from the philosophical transactions of the Royal Society, and from the transactions and proceedings of other English and foreign public societies, and from scientific periodicals, &c. The collection is a very complete one, particularly in Italian, French, and German, and may almost be said to be unique.

Sir Francis Ronalds has been long known to the scientific world as the author of a small and now scarce book, the first ever published on the subject of the Electric Telegraph.*

This book describes a system of Electric Telegraphy, which its author invented and worked as early as 1816. The invention was a perfectly practicable one, and has gained for its author, from more than one learned authority, the title of "The father of Telegraphy." The invention, however, was produced some thirty years before the world was prepared for it, as is shown by the reply of the Secretary of the Admiralty in dismissing an application which had been submitted to him. It was as follows:—

"Mr. Barrow presents his compliments to Mr. Ronalds, and acquaints him with reference to his note of the 3rd instant that telegraphs of any kind are wholly unnecessary, and that no other than the one now in use will be adopted. 5th August, 1816." †

The result was that the telegraph remained nothing more than a successful experiment. Sir Francis Ronalds was, from his scientific attainments, and from his knowledge of foreign languages, well fitted for the task he set himself, and it is very much to be regretted that he did not live to see his work issued from the press. He received the honour of knighthood about three years before his death in recognition of his early contributions to electrical science.

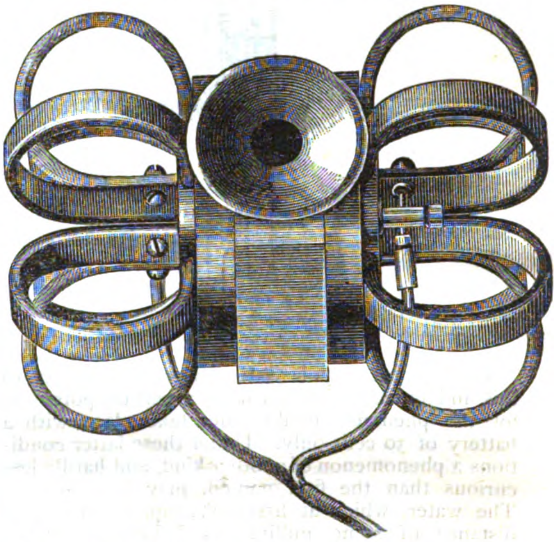
In conclusion it may be added that owing to the fact that most of the books and pamphlets are in an unbound condition, the library has not yet been opened for reference. The binding will, however, be quickly proceeded with, when the library will, under certain conditions, be opened to students and those interested in the subject to which the collection refers.

* Descriptions of an Electrical Telegraph, and of some other Electrical Apparatus. By Francis Ronalds. 8vo. London, 1823.

† Journal Society Telegraph Engineers, Vol. IV., p. 5, 1875.

PHELPS' "CROWN TELEPHONE."

The figure illustrates the double form of Mr. Phelps' Crown Telephone, which is used in America in conjunction with Edison's Carbon Telephone. It consists of two magneto-electric crown telephones united. Each of these consist of a coil, diaphragm of iron, and six permanent magnets. The six magnets are placed with their like poles together in the centre of the coil, the other poles being bent round, as shewn, into contact with the periphery of the diagram. Thus the diaphragm forms the other



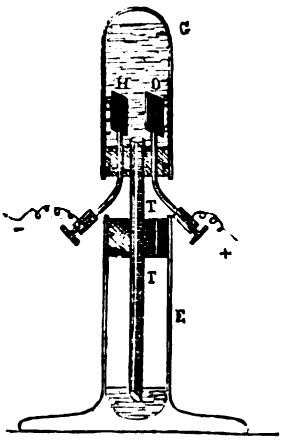
pole to that within the coil, and in this way the magnetic field is intensified. In the double crown form, the two diaphragms are separated by a cavity, or air-chamber, with a mouthpiece or orifice, into which the person speaks. The coils are so connected in circuit that the vocal currents generated in each coil strengthen one another. In a recent trial of this instrument at Dr. Well's church, Brooklyn, New York, with Edison's carbon transmitter, an audience of three hundred persons distinctly heard speaking and music, both vocal and instrumental, in every part of the hall.

BERTIN'S EXPLODING VOLTAMETER.

This little known experiment is very interesting, in that it makes apparent certain phenomena of polarisation of the plates of an electrolyte which are ordinarily produced under different conditions. The instrument constructed by M. Ducretis, and of which a figure is given, is composed of an inverted bell G, closed by a cork, through which are inserted two platinum wires, terminated by large

electrodes, H and O. This arrangement is supported by a glass tube T, open at its two extremities, and fixed in the cork of a glass vessel E. Two terminals + and — serve to connect the platinum wires with a powerful battery (50 Bunsen cells).

The bell G being filled about one-tenth full with acidulated water, the battery is connected to the apparatus, and the decomposition of the liquid which results, forces the latter out of the bell into the vessel E, and when the bell is almost full of gas, the mixture explodes spontaneously, and the bell is illuminated. This experiment is without danger, the recomposition of the products of the electrolysis taking place spontaneously, and during the passage of the current.



The current of polarisation which gives place to this inflammation should have a certain potential, for the phenomenon does not take place with a battery of 30 cells only. Under these latter conditions a phenomenon of another kind, and hardly less curious than the first named, may be observed. The water, which at first sinks rapidly in G to a distance of some millimetres below the plates, suddenly stops, in spite of the disengagement of gas which takes place from the portion of the wires below the plates. With well water the decomposition of the water is less rapid, and the explosion is not produced even with 50 Bunsen cells. But another curious phenomenon is observed. The water sinks down to the base of the plates, and at that moment commences to rise again, and this oscillation is continuous, the water being alternately decomposed and recomposed. A current of less strength than 30 cells effects decomposition only. These phenomena are entirely due to the polarisation of the electrodes, and not to the catalytic force of the platinum, for the same results may be obtained with electrodes formed of other metals.—*L'Electricité.*

THE THERMOPHONE.

By THEODOR WIESENDANGER.

THE deficiency in intensity of the sound produced in the ordinary telephone has been considered to be due to magneto-action. For this reason, scientific men have thought it expedient to advise inventors to abandon the known principles, and, if possible, to open a new route of progress in telephony.

I have devoted a great amount of time and much effort to this end, and have obtained some interesting results. In looking for a new source of sound for the telephone, I directed my attention to *(a)* the sonorous vibrations produced by the expansion of bodies under the influence of heat, and *(b)* to the production of heat by means of the electric current.

Whenever a quantity current is sent through a circuit consisting of two stout copper wires, to whose extremities are attached the ends of a bad conductor, say a short piece of thin platinum wire, the latter immediately becomes red hot, and, if the current be powerful enough, it instantaneously fuses. It should be remembered that no appreciable amount of time is required for this action. Sulphide of copper is known to develope so much heat under these conditions as to form the prime element of an efficient electric fuse. Gas carbon and other bodies of low conductivity show the same results. The resistance thus interposed converts a portion of the electric current into heat. As bodies are known to expand when subjected to a higher temperature, the platinum wire, or gas carbon, or sulphide of copper, &c., will increase in length, width, and height, and thereby produce a condensation in air. (I would point out here that soft iron or steel under the influence of electro-magnetic induction only increase in one dimension.) When the above-named substance cools it contracts, and must cause in the surrounding air a rarefaction to a corresponding degree. When these impulses re-occur periodically in rapid and regular succession, they produce on the human ear the impression of sound.

While experimenting on this subject, I employed an electro-magnet, whose coil consisted of a tubular piece of inferior iron, the coil of copper wire (No. 26). I noticed, with interest that, under the influence of powerful currents, produced by the battery of my "music telephone," the magnet in a short time became appreciably heated. Iron of inferior quality is very intolerant to electro-magnetism, and this resistance to induction produced the heat. I thought, then, to have discovered here a means of intensifying the effects above described by utilising as a source of heat not only the resistance of a bad conductor to the passage of the electric current, but also the resistance offered by iron or steel to electro-magnetic action, the energy inadequately termed "coercive force." Direct electro-magnetic action has been employed in our instruments to a limited extent only. The combined effects of these three kinds of impulses produce what, until now, was vaguely called "molecular vibration." The bad conductors I interpose in my instruments are small coils of very thin insulated wire of German silver, platinum, or copper. The sounds emitted by these coils are quite distinct, but very faint, and I intensified them by adding the effects of the resistance of coercive force to electro-magnetic induction, and also by producing these sounds on resonant surfaces or cavities. By these means I succeeded in constructing very efficient receivers without the use of magnets proper. One of these instruments, fig. 1, is of the following construction.

Three discs of thin charcoal iron, one $\frac{3}{8}$in. diameter, the other two of 3in. diameter, are varnished on both sides and afterwards glued together, the smaller disc between the centres of the two larger ones. A very thin reel *e f*, is thus formed, and on it is wound a coil of about five to ten yards only of silk-covered copper wire, No. 36.

This reel is then glued on the centre of a thin membrane, *b c*, stretched over one end of a brass tube A, 4in. long, $3\frac{1}{2}$in. in diameter.

Another receiver is constructed, as shewn by fig. 2:—A tube of tinned iron, *c d*, 6in. long, $\frac{3}{8}$in. in diameter, is soldered in one spot only (not all round) to the centre of an ordinary Bell's telephone

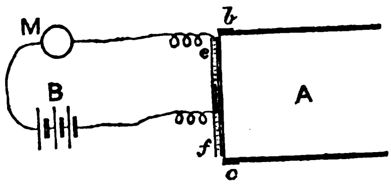


Fig. 1.

disc *a b*, mounted on a stand. A coil, *e f* such as described above, or longer, is wound round the tube in close proximity to the disc. This disc and tube combined prove to be an excellent resonator. I find it as delicate to sonorous vibrations as the acoustic telephone with the string kept tight. With this receiver I hear the tune of a musical box and speech reproduced with great fidelity in quality as well as in pitch, and with considerable intensity. A tube of tinned iron, 3in. long, and $\frac{5}{8}$in. in diameter, wound with a small coil of insulated wire, will reproduce telephonic sounds.

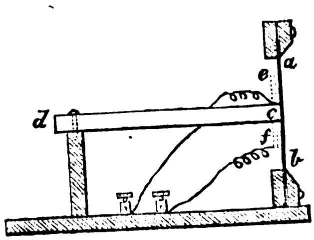


Fig. 2.

In both cases a battery B, and ordinary microphonic transmitter M, are connected in the circuit.

Fig. 3 represents a form of thermophone where the bad conductor interposed is a long and thin rod of gas carbon or plumbago. In this arrangement *a b* is an ordinary Bell telephone disc, *c d* a spring, *f g* a carbon rod, *h* a spring support, *k* a spring for adjustment, and *l* an adjusting screw. The carbon rod resting on a spring support, can be made to bear with different amounts of pressure on the centre of the disc by means of the adjusting screw. This instrument acts well as a receiver after the exact adjustment has been experimentally determined, an operation which sometimes involves much time and patience. It need hardly be mentioned here that the same instrument forms an efficient transmitter.

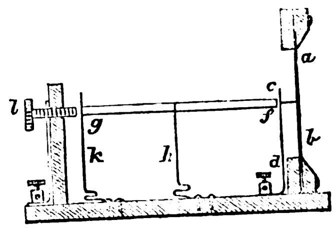


Fig. 3.

These instruments forcibly demonstrate that neither disc nor magnet are essential portions, but only accessories of a telephone receiver, and their performance cannot leave any doubt as to the correctness of the theory we expound.

Nevertheless, I must expect adverse criticism on my explanation of the action of these instruments. The principal theoretic argument brought against me, will be that a succession of changes of temperature so infinitely rapid as to produce sound by the expansion of the bodies acted upon is an impossibility. But exactly the same argument was used against the rapidity of electro-magnetic changes until the performance of Professor Bell's telephones vanquished the rash hypothesis.

I would refer those who entertain any doubts to experimental verification of these facts, and ask them to wind *one* yard only of insulated wire around an ordinary steel spool of a sewing machine, to include that miniature coil together with a strong battery in an electric circuit, and to make and break contact very rapidly. The results thus obtained will be a more convincing proof than any assertions I can make in writing.

While engaged in active research on these receivers, I heard reports on Mr. Blythe's and Mr. Hughes' microphone receivers; and it struck me then that the principle of action of these instruments was exactly the one I was experimenting upon. The carbon, as an inferior conductor, offers a considerable resistance to the passage of the electric current, its temperature is raised in degrees corresponding with the intensities of the currents sent, and it will expand by heat in degrees corresponding with the undulations of the current as produced or varied in the transmitter by sonorous vibrations of different amplitudes.

I was struck not to hear of any successful repetitions of Mr. Blythe's experiments. The principle of action evidently had not been understood, and experimenters, instead of using quantity currents, employed the usual microphone batteries, which are, of course, exceedingly weak, and whose currents only produce minimum effects of the nature described.

The principle I have explained allows of a great many different applications. I have produced a variety of receivers; none are so perfect as I could wish, nor even so efficient as a good "Bell's telephone;" but

no doubt, inventors and other students in telephony will take up the work and experimentally develope it further. So far, I feel satisfied in having discoved the principle and experimentally established the possibility of reproducing sounds by thermo-action, through conversion of forces. A new route is thus opened to scientific research, and to progress in telephony.

THE ELECTRICAL PROPERTIES OF BEES WAX AND LEAD CHLORIDE.

By Professors J. PERRY and W. E. AYRTON.

Abstract of Paper read before Section A of the British Association, August, 1878.

PROFESSOR AYRTON commenced by noting the close way in which investigations in the various branches of physical science were linked one with another, and by remarking that experiments on electric absorption ought to have no less interest for the scientific engineer than those on the increasing strain of materials under constant mechanical stress had for the electrician. He next explained how, in consequence of the absorbed charge in water being immeasurably greater than the surface charge, the direct method of determining experimentally the specific inductive capacity employed by Mr. Perry and himself, in their experiments on "Ice as an Electrolyte," failed to give the result equal to the square of the index of refraction for light of infinitely long waves, and he suggested that the method recently employed by Mr. Gordon for measuring the specific inductive capacity of solids with very rapidly reversed charges might possibly, if applied to water, give an answer approximately more equal to the square of the index of refraction; however, he was inclined to think that, since Mr. Gordon's method for solids gave (after the application of the proper correcting factor for the thickness of the dielectric) numbers closely agreeing with the received specific inductive capacities, there existed no known method for correctly ascertaining the electric capacity of a liquid.

For although a condenser might be made of opposed metallic plates separated by a space almost entirely filled with a liquid dielectric, which did not, however, touch either plate, and although, according to the ordinary nomenclature, the two plates in such an arrangement would be said to be insulated from the water and from one another, still, as explained in their paper on the "Viscosity of Dielectrics," a succession of rapidly reversed charges would be accompanied by *true electric conduction;* in fact that it would be well worthy of consideration whether the explanation of the result which Mr. Gordon had brought to their notice at this meeting, viz.: that his new method of measuring specific inductive capacity of solid dielectrics had given the old results might not be found to consist in this *conduction*—this viscous conduction he might term it, although in reality there was but one kind of conduction, the conversion of electric energy into heat—for this conduction would occur unequally in the two apparently balanced condensers, since the two dielectrics varied in viscosity, consequently the balance of capacities was not a real one.

Nevertheless Professor Ayrton thought it highly important that careful experiments should be made, both with constant and with rapidly reversed charges, on the inductive phenomena observed in such a water condenser as he had described.

The abnormal rise in the specific inductive capacity of bees' wax, on solidifying, which the experiments of Professor Perry and himself had shown, coincided with an increase in the index of refraction; he regarded this as furnishing an important addition to the experimental proof of Professor Clerk-Maxwell's electro-magnetic theory of light, and he hoped that some of those philosophers of Trinity College, Dublin, who had so successfully turned their attention to the elucidation of the molecular vibrations causing Crookes' force, would give their views on the molecular vibrations accompanying wave motion and electric induction.

He thought that the experiments described in the paper on bees' wax and lead chloride showed, in a sufficiently satisfactory way, that, where the resistance of an electrolyte diminished by electrification, it was due to the electromotive force employed being sufficiently great to decompose the damp in the pores of the electrolyte; but, in view of the fact that the resistance of water itself increased by electrification, it seemed to follow that the products of the decomposition of the damp must act chemically on the solid electrolyte and cause deterioration, and hence a smaller specific resistance. But if there were deterioration we should expect that the specific resistance of the material would steadily diminish day by day, a result that was not obtained in the experiments of Professor Perry and himself, on bees' wax at any rate, as will be seen on examining the table given in the paper in the *Philosophical Magazine* for August. He therefore concluded that further experiments on electrolytes, in which resistance diminishes by electrification, were necessary to make the explanation quite complete.

NEW MAGNETIC FIGURES.

By SILVANUS P. THOMPSON, B.A., D.Sc., Professor of Experimental Physics in University College, Bristol.

Abstract of Paper read before Section A of the British Association, August 19th, 1878.

THE author desires to draw the attention of the Section to the series of magnetic figures exhibited, which has recently been completed. The figures are permanently secured on glass by a process described in recent communications to the Physical Societies of London and Paris; and they have also been photographed as transparencies for the lantern.

It is believed that the figures assumed by iron filings in magnetic fields of many different kinds, in the series now produced, will be found of great use in the study and teaching of known laws of magnetic and electro-dynamic action, and also in the experimental determination of the action of magneto-dynamic and electro-dynamic systems and machines. Faraday discovered that the lines of force traced out thus by iron filings possessed a significance hitherto disregarded, and revealed indeed the very seat of the attractions and repulsions taking place between magnetic bodies. The method had indeed been imperfectly employed by Musschenbrock at an earlier date, but it only became really fruitful in the hands of Faraday. The author has applied Faraday's reasoning to the figures produced by electric currents traversing conductors in various circumstances, and finds that from the figures alone nearly all the recognised electro-dynamic, magneto-dynamic, and magneto-electric relations can be deduced, or verified.

The series of figures now presented illustrate amongst other matters the following actions:

(1.) The attraction (or repulsion) of magnets by magnets.
(2.) The attraction (or repulsion) of currents by currents.
(3.) The attraction (or repulsion) of magnets by currents.
(4.) The rotation of magnets by currents.
(5.) The rotation of currents by magnets.
(6.) The rotation of a magnet round its own axis under the influence of a current.
(7.) The repulsion by a current of its own parts.
(8.) The mutual inductive action of solenoids and magnets, and of magnets and magnetic matter.
(9.) The flow of currents in conductors and conducting media.
(10.) The action on magnets of magnetic media.
(11.) The action of magnetic instruments, magnetometer, galvanometer, electro-dynamometer.
(12.) The action of magneto-electric machines.
(13.) The magnetic properties of cobalt and nickel.

The figure illustrative of the lines of force surrounding a current has been previously given by Faraday, Guthrie, and Barrett. Those illustrative of the attraction and repulsion of parallel currents, by Faraday, but imperfectly. Those illustrative of flow of currents in conductors by Kirchhoff, Guthrie, and Carey Foster and Lodge.

Those illustrating the action of the galvanometer and the Gramme machine were suggested to me respectively by Mr. C. W. Cooke, and Mons. A. Niaudet.

The photographs have been executed directly from the filing figures by Mr. Robt. Gillo, of Bridgwater, of the firm of F. York & Co., of Notting Hill, the eminent manufacturer of photographic transparencies for the lantern.

ON LIGHTNING CONDUCTORS AND ACCIDENTS BY LIGHTNING.

By RICHARD ANDERSON, F.C.S., Member of the Society of Telegraph Engineers.

Abstract of Paper read before Section A of the British Association, August, 1878.

At the present time at least one-half of all the public buildings, including the churches and chapels, of Great Britain and Ireland are without protection against lightning. As to private houses, it is safe to assert that not five out of every hundred have lightning conductors.

According to the reports of the Registrar-General, the number of deaths from lightning in England and Wales during the eight years from 1869 to 1876 reached a total of 182.

According to the report of Dr. Engel, Director of the Statistical Bureau of Berlin, the number of lives lost during the same period in Prussia was 819.

The terrible losses, both of property and human lives occasioned by lightning, are mainly due to three causes, namely: first, in not providing any lightning conductors at all; secondly, in not placing them in the right position, or in sufficient number to cover a given area; and, thirdly, in not having them regularly tested, so as to ascertain their constant efficiency. Even some of the first cathedrals of England, such as Peterborough, have no lightning conductors whatever, while others, supplied with them, Windsor Castle for example, are insufficiently protected, as is apparent to any competent observer.

If the entire absence of lightning conductors is the most prevailing cause of the still exceedingly great number of casualties occasioned by lightning, that of ill-placed or insufficient conductors is another deserving much attention. The mischief done in this case is not only that the conductor gives a false security, but that, should the dwelling on which it is placed be struck by lightning, it leads to the belief that the wonderful scientific discovery of Franklin is nugatory, or at least uncertain in its action. A case of the most instructive kind, in which a house with a proper conductor fixed on it was struck and damaged by lightning, came under my own observation quite recently; a heavy thunderstorm passed over it, and the electric discharge fell on one of the towers, knocking down part of a crenellated wall, not more than three yards from a lightning conductor, and then passing off without doing further damage. The conductor being new and in good order, it seemed at first sight a very extraordinary case; but the mystery of it was soon explained by an examination of the premises, which I undertook. I found that the roof of the tower on which the lightning fell was covered by a solid mass of lead, of unusual thickness, connected at one end with a large iron water-pipe about four inches in diameter. In this case the electric force, to get to this rival conductor, heavier in metal than the one designed for the purpose, and therefore offering the best road earthward, had to smite the brick wall in its way, and having done this, it went down the iron water-pipe into the ground, doing, as already mentioned, no more damage. Had the actual conductor either been larger, that is, heavier in metal than it actually was, or had it been connected with the mass of lead in the first instance, the lightning could never have struck the house. The incident forcibly illustrates the necessity of leaving the design and erection of lightning conductors to no others but those who have made a thorough study of the subject, since the work is not by any means so free from complexity as is commonly believed.

The third cause is the utter neglect of the conductor, when once it has been put in its place; other repairs to all sorts of public buildings are regularly executed, but the lightning conductor is taken no notice of and is never tested.

Having drawn attention to the chief causes of the numerous and fatal casualties caused every year by lightning, I have only to add a few words of advice as to how they might be prevented, or at least greatly diminished. First of all, I think it most desirable that public recommendation should be made, by local and other authorities, to place lightning conductors on all exposed or high-lying buildings, whether public or private, as well as on those standing near woods and on moist ground. It might be well worth the trifling expense to place simple conductors also against trees in parks, under which there are benches, or where persons are likely to gather during a thunderstorm, they forming a prolific source of fatal accidents. Above all, no church, chapel, school, prison, or other large public building, ought to be without one or more lightning conductors. But if it is necessary to greatly multiply lightning conductors, it is equally so that they should be planned, erected, and also periodically tested by competent persons, with scientific as well as practical knowledge of the work. The testing should take place at regular intervals, perhaps best in the spring, before the advent of the summerly thunderstorms, and it should likewise be made whenever a building has been undergoing repairs which may have damaged the conductor. To show the importance of constantly testing even the best laid conductors, I can cite another instructive case where a house was apparently well protected. On the 19th of August, 1876, shortly before midnight, a heavy stroke of lightning fell upon a mansion near Kew Bridge, Middlesex. The electric force destroyed the top of a large chimney, knocking off part of the coping, not more than two or three feet from a lightning conductor, to which it then flew, making its way down to the earth, but not without causing the greatest disturbance all along its path—lifting up, among others, some heavy marble toilet tables in bed-rooms some six feet distant on either

side from the copper rope, which under ordinary circumstances, would have carried the electric force noiselessly, as well as harmlessly, to the ground. The fact of this disturbance indicated at once the source of the mischief. The lightning conductor, good as it otherwise was, had no sufficient earth connection. It went into the earth, it is true, but into soil altogether dry, and therefore the conductor did not, and could not, act properly. Nothing was wanting in this case for protection against lightning but regular testing, in default of which it can never be known whether a conductor is actually efficient at any time. A well organised system of inspection of lightning conductors would be most inexpensive. The galvanometer used for the purpose has been latterly much improved in Germany, and small portable instruments, of the size of a diminutive carpet bag, are now made, which leave nothing to be desired in the shape both of effectiveness and durability. Already such a system of inspection and testing of conductors exists in Paris and several other French towns. Shall we say, once again, "They manage these things better in France?"

Correspondence.

THE THEORY OF THE MICROPHONE.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—In my letter of the 10th, which you were good enough to insert, I made reference to some experiments with the microphone, which I undertook with a view to ascertain the nature and action of Professor Hughes' discovery, and which have led me to form an opinion at variance with that of the molecular distention theory given by Mr. Hughes.

It is difficult to comprehend that vibratory motion can cause molecular expansion, if this were true. The carbon should become specifically lighter whilst undergoing vibratory movement. I am not aware that such is the fact. Professor Hughes assumes that the carbon pencil elongates under vibration, and so alters the pressure of contact, the resistance of which varies with the rise and fall of the acoustic wave.

Having employed a Riess's transmitting apparatus to open and close a primary circuit of an induction coil, the secondary of which was connected to the line wire, I succeeded in growling out the tune of "God Save the Queen." The receiver very considerably augmented the loudness of the original, but articulation was not arrived at.

What, then, is the difference between two platinum and two carbon contacts.

Or, why does Riess's transmitter fail to articulate while Professor Hughes' does this very perfectly?

In the platinum contact-maker you do not obtain sound until the amplitude of the sonorous vibrations is sufficient to interrupt the circuit, and as a consequence, a bright and explosive arc is the result. It is this little explosion that produces the jarring sound which I have described as a growl.

Mr. Teutes, of Dublin, succeeded in obtaining articulation with a Riess transmitter by simply moistening the platinum contacts to prevent the entire disruption of the circuit whilst the contact-maker was vibrating. Imagining some such cause to be at work in the microphone, I devised a plan to examine the nature of the circuit by bringing the two contact points of the microphone carbons under view of a powerful microscope.

The microphone, which was of the hammer and anvil construction, I placed near the end of a light lath; the other end of the lath being fixed to a sounding board maintained in a state of vibration by means of a tuning fork.

Whilst the tuning fork vibrated, a clear space was visible between the carbon contacts by aid of the microscope, the magnifying power of which was about 350 times.

I then connected the leading wires from the microphone to a battery of 4 volts tension; the circuit I could open or close at pleasure by a little tapper key.

Each time the key was pressed a gray cloud traversed from carbon to carbon, the cloud being most dense at the time of closing the circuit. This, then, explains the action of the microphone; the carbon may be regarded as an aggregation of conducting particles, which become, under vibration and attrition, loosened at the contact points, in the form of very minute powder, so impalpably fine as to defy microscopic definition, escaping as a cloud darkening the field of view, and may be regarded as a conducting vapour which maintains the circuit. The approach or the recession of the contact points shortens or lengthens the conducting column, reducing or augmenting the resistance in the circuit, and thus makes the electric and sonorous waves sympathetic.

Yours, very truly,

Sept. 23, 1878. FREDK. H. VARLEY.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—On page 71, *Telegraphic Journal*, for February 15, 1878, there is an appalling formula for localising a partial disconnection in a submarine cable when there is an earth current in it. The formula is rendered very obscure by the way in which it is printed. A portion of the second term of the right hand number of the equality is under the symbol for extracting the square root, and the remainder, which is below it, looks like a multiplier of this portion. The latter is intended for a continuation of the second term under the symbol, which is a fraction, but whether the continuation, also a fraction, belongs to the numerator of the former, or whether the two numerators and the two denominators are both continuous is not evident. The author works out his example on the second assumption, and *by halving the first term under the square root symbol* arrives at a very happy result. But if the formula is correct, R = — 1047, from which we may surmise that the fault is "on the other side of Jordan."

Yours truly,

H. A. W. FANSHAWE.

[The formula you refer to should be as follows :—

$$R = \frac{L_1 + L}{2} - \sqrt{\frac{(L_1 + L)^2}{4} - \frac{3 Q_2 L \dfrac{n(G + L_1)}{n(G + L_1) + G - \rho}(G + L)(\rho + L_1) - L^3 Q_1}{3 Q_1 (L_1 - L)}}$$

The numerical example, which was given, is perfectly correct. With reference to the "appalling" nature of the formula, we must remark that it is so only in your imagination, as when the numerical values of each of the quantities are obtained, ten minutes at the most would suffice to work out the value of R (at least, for anyone of ordinary intellectual capacity), and we can hardly believe that that amount of time would be grudged, especially when the formula may be required for use but once in the course of a year.

Your algebraical proof of the principle of the Wheatstone bridge we must confess, does not appear to be a proof at all. To commence with, it is not evident by what process of reasoning you obtain the equality $A = \frac{b}{a+b} F$; but granting that this and the equations $B = \frac{a}{a+b} F$ and $\frac{G_1}{G_2} = \frac{AC}{Bd}$ are correct, it seems to us that

these, when $G_1 = G_2$, are quite sufficient to prove the truth of the equation $ad = bc$, without the other equations which follow. Perhaps, however, we have misunderstood your explanation.—EDIT. TEL. JOUR.]

J. BROWN.—Articles and notes on Electric Light &c., will be found in the pages of this Journal as follows:—June 1, May 15, November 1, December 15, 1877; January 1 and 15, April 15, May 15, June 1, and July 15, 1878. Gramme's Machines, January 15, February 15, 1873; September 15, 1874; January 1, August 15, September 1, October 1, 1875; December 15, 1876, September 1, 1876; August 15, 1877. Breguet's Machine, April 1, 1876. Siemens' Machine and Lamp, November 15, December 1, 1877; Varley's Electro-Static Multiplier, May 1, 1878. Lodyghin and Kosloff Lamp, May 15, 1874; October 15, 1877. Jablochkoff Lamp, November 15, 1876; May 1, 1877. Rapieff Lamp, August 15 and September 1, 1878. Regnier Lamp, February 1, 1878.

Reviews.

Posts and Telegraphs, Past and Present; with an account of the Telephone and Phonograph. By WILLIAM TEGG, F.R.H.S. W. Tegg & Co., Pancras-lane, Cheapside.

MR. TEGG, the well-known publisher, is the author of several entertaining and instructive volumes, such as *Meetings and Greetings of all Nations, One Hour's Reading*, &c. They are characterised by a genial style, a sense of humour, and, at the same time, a strict accuracy and a power of seizing upon the most salient and instructive points of the subject in hand. The present work is no exception to the rule. It is designed for the general public, to acquaint them with the origin and history of the letter and telegram posts in this country, and, indeed, in the world. A happy thought on Mr. Tegg's part, for although everyone uses the post and the telegraph nowadays, it is remarkable how few understand either how they have arisen or how they are carried on. This is especially the case with the telegraph, and Mr. Tegg's handsome little book should enlighten them upon the subject in a light and readable form. Although the book is enlivened by annecdotes and a touch of fancy here and there, it must not be supposed that it is ever trivial, or sacrifices accuracy to sensation. It is not intended to be a scientific book, or a book for the specialist, yet it is a book which the telegraphist and professional electrician may read with pleasure and profit, for it contains a connected history of the postal and telegraph sevice and their operation, with some account of the Atlantic cables. The telephone and phonograph are added for the benefit of the general readers.

Lightning Flashes and Electric Dashes. A volume of choice telegraphic literature, humour, fun, wit, and wisdom. Compiled by W. J. JOHNSTON, Editor of the *Operator*, &c.

Lightning Flashes and Electric Dashes is the rythmical title of a contribution to telegraphic romance, now well known on the other side of the Atlantic. We have been told by Mr. W. H. Preece how popular the telegraph service is in America, and the appearance of a new edition of this book is pleasing evidence of the fact, for it is read not only by American operators (who, we must say, are fired by a praiseworthy zeal for their calling, which is refreshing to see), but by the general public also. It is always interesting to look over a literary novelty such as this is, in order to discover if it contain any traces of true merit, any grains of gold among the dross; and we have been gratified in finding that our quest here was not in vain. *Lightning Flashes* contains some miscellaneous samples of considerable native literary power. The best writers are Mr. W. P. Phillips, or "John Oakum," the author of "Oakum Pickings," Charles Barnard, Miss Schofield, the young Canadian lady operator who recently in a fit of insanity precipitated herself over Niagara Falls, and Mr. J. M. Maclachlan, a superintendent of our own telegraph service, St. Martin's-le-Grand. Most of the pieces have been republished by Mr. W. J. Johnston from the *Operator* journal. The book is illustrated by cartoons of Mr. J. J. Calahan and others. While upon this subject, we may mention that a new story, entitled "Sam Johnson; the Life and Experience of a Railroad Telegraph Operator," by Mr. J. A. Clippinger, one of the contributors to *Lightning Flashes*, is about to appear in America. The insight which writings of this kind gives into telegraph life in America should render them of additional interest to the fraternity in England. The travels and experiences of an American operator, if written with spirit, power, and good taste, would "make a hit."

Notes.

MR. JAMES TYMAN writes to a recent number of *Design and Work* to say that he has successfully applied Herr Glafscorp's electric light to his bicycle. The motor is the hind wheel of the bicycle, and the machine is a small ordinary magneto electric machine with rotary magnet, aided by a small pocket battery. The carbons are regulated by a train of wheels, actuated by the front wheel of the bicycle, the consumption being about one inch per hour. The apparatus takes up the room of a small valise, and has cost in all about £5. The light is steady and equal to 120 candles, its great advantage being that it lights up the road thoroughly for 200 yards a-head on a dark night.

MAGNETIC SLEEP.—In an interesting case recently tried at the Court of Session, Edinburgh, the plaintiff claimed £500 damages from the defendant, Mr. Joseph Agnew, a surgeon-dentist, of Glasgow, for injuries incurred by magnetic trances to which the defendant was in the habit of subjecting him. The experiments consisted in placing large magnets in front of, behind, and above the plaintiff's head, the magnets being connected to the head by magnetic chains. During these experiments, which were undertaken in secrecy, at the defendant's request, the plaintiff's mind became seriously affected, and after repeated *seances* he became insane, while losing his physical health also. The plaintiff was the shop boy of the defendant. The defendant stated that he was interested in the subject of

magnetic sleep, and had tried experiments, but without effect. The case has not been concluded.

The Unseen Universe and the Tasimeter.—The extreme delicacy of Edison's tasimeter has been proved during the recent solar eclipse, and we now hear that the latest piercing project of Mr. Edison is to employ it in exploring those blue fields of the night sky, which to the eye are void of stars, in order to discover the unseen orbs which tenant them. His plan is to adjust the tasimeter to its utmost sensitiveness, then attach it to the exploring telescope, when, if in any particular direction of the latter there is a marked and invariable deflection of the tasimeter, it may safely be inferred that there is an unknown world in line. "Seeing," says the *Scientific American*, "that the tasimeter is affected by a wider range of etheric undulations than the eye can take cognisance of, and is with all far more acutely sensitive, the probabilities are that it will open up hitherto inaccessible regions of space, and possibly extend the range of our real knowledge as far beyond the limit attained by the telescope as that is beyond the narrow reach of unaided vision. Possibly too, it may bring within human ken a vast multitude of nearer bodies—burnt out suns or feebly reflecting planets—now unknown because not luminous.

Wheatstone's automatic system has been introduced on the Odessa to Constantinople cable. The speed obtained is twenty-eight words a minute, whilst with the Morse, only ten to eleven words a minute were got.

The *Journal Telegraphique* states that the telegraph lines of Servia and Roumania, interrupted during the war, are still in that condition.

According to the terms of the agreement between Germany and Russia, which will be enforced on October 1, a fixed tariff per word has been substituted for the tariff for twenty words, hitherto in vogue between these countries. For an ordinary telegram a fixed tax of fifty centimes (without regard to number of words) and a tax per word of forty centimes will be charged. For an urgent telegram this rate will be tripled; and for a repeated telegram they will be raised by fifty per cent.

The Italian telegraphic revenue for 1877 amounted to £313 16s. 9d.

The electricians of the Australian Overland Telegraph Line have cured the hostile natives about Macdonald's Peak of a propensity to cut the wire, by connecting it to a powerful induction coil, and administering a small thunderstroke to the boldest of them. The "black" is not a very reverent individual, but he respects lightning.

It is said that there are already 16,157 miles of wire working quadruplex, and 14,580 miles working duplex in America already.

Telegraphic Progress in America. In the *Telegrapher* of May 17, 1873, a contribution from Mr. F. L. Pope was printed, entitled "Twenty Years of Telegraphic Progress," which will be found of interest at the present time. Five years have passed since this article appeared, and the progress of the electric telegraph has been even more marvellous than during the years preceding. The miles of telegraph wire in use have within that time practically more than doubled. There are now over 300,000 miles of wire in actual use in this country, beside 64,000 miles of what is termed "phantom" wire, that is, additional circuits created by the introduction of duplex and quadruplex systems of telegraph. About 13,000 offices and over 20,000 persons are employed in the telegraphic service. The demand for telegraphic facilities constantly increases, and what the future may witness in telegraphic development it is as impossible to forsee now as at any previous time.—*Journal of the Telegraph*, U.S.

A magnetic survey of the State of Washington, U.S., in connection with the weather service has been commenced. There will be 25 stations to determine the magnetic elements, and the work will take three years to complete.

Recently has been issued in America a work entitled "*The Telegraph in America*," by Mr. J. D. Reid, who has been for several years engaged in its preparation. It is a record of the telegraph in America; its rise and development, and will be richly illustrated. The price is five dollars, and it can be had of Mr. Reid, P.O. Box 3393, New York. The late Mr. Orton took a great interest in the progress of this work.

At Oswego, U.S. recently, a message running "Send one hundred currency 4 paid," was received by a "travelling operator" as follows: "Send one trunk red currants—4 paid." It is dangerous now to mention red currants within that operator's hearing.

Electricity and the Camera.—We learn from the *Operator*, U.S., that an old hulk called the *Royal George* was recently blown up by torpedoes at Willets Point, near New York, and successful negatives taken of the explosion by means of electricity. Gen. Abbott U.S.A., superintended the process. The torpedoes were fired electrically; while along the shore four cameras were pointed at the scene of the explosion. The shutters of the cameras were suspended by threads which could be burned by fuses ignited electrically, so that the shutters would fall at any desired time. A chronometric clock in circuit registered these times of closing the camera and obtaining the negative.

Relative Intensity of Lights.—M. Bertin in a recent article in the *Journal de Physique*, on the electro-magnetic rotation of liquids, draws up the following table of intensities, the solar light being reckoned at 1,000: Electric light of *Alliance* machine, 250; Drummond light, regulated to noisy state, 24; Drummond light, regulated to ordinary state, 15; gas burner, with glass chimney, forced flame, 1½; gas burner, with glass chimney, ordinary flame, 1; Carcel lamp of Pictet, or Moderator lamp, large model, 1; star candle (five to the pound), ⅐.

A correspondent to *Nature* points out that the spectrum of Jablochkoff's electric candle is a union of the electric and lime-light spectra.

Lightning.—During one of the thunderstorms which have been so frequent recently, a harvest labourer, Edward Dennis, aged 60, was killed by lightning. His body was found between some shocks of wheat; and it is supposed that he was on his way to seek the shelter of some cottage when he was struck. He had left his sickle behind him. He was much discoloured about the face; his right whisker was singed off and there was a jagged wound on the right ear from which blood had issued. This wound was not such as might have been inflicted by an instrument. His clothing, from the upper part of his body downwards, was torn into shreds. His boots had been riven from his feet and were scattered about in scraps—the soles, which were nailed, having been separated from the uppers. His hat had also

been torn in pieces by the discharge, which had furrowed the ground for some distance around him.

ANOTHER interesting case of lightning-stroke was related in a recent issue of the *Lancet*. A shepherd, sheltering under a tree, felt a blow on the right shoulder, and, immediately loosing the use of his legs, sank to the ground. On being taken home he gradually recovered from the numbness in his limbs, but still felt severe pain in the back and legs. On examination, a symmetrical fern-like mark of a bright scarlet was found to brand his back obliquely from the right shoulder to the left hip. It was raised above the rest of the skin. The midrib was ¾-in. wide and there were six or eight fronds regularly arrayed. In time the figure gradually faded away. This case recalls that of Mrs. Pidgeon, at Torbay, which was fully described in *Nature* for March, 1875.

THE order for dismissal of the suit of Edison against the Western Union Telegraph Company, on the ground of the non-residence of the defendants, was rescinded by Justice MacArthur, in the Equity Court at Washington, July 20th. This will place the suit, which is to test the ownership of the patent for the quadruplex telegraph instrument, on the calendar to be tried on its merits.—*The Operator*, W.S.

BEADED LIGHTNING.—The attention of the Lit. and Phil. Soc. of Manchester has been drawn by Mr. St. J. B. Joule to a remarkable form of lightning witnessed by him on the evening of Aug. 16, last year. The chief peculiarity of the flash was its intermittent or dotted character, like the spark sent along the intermittent tinfoil circuit on Leyden jars for lecture illustration. Part of the flash was zig-zag, and the rest curved. A correspondent in *Nature* confirms the fact that lightning occasionally takes this form, which is called by him the punctuated" form; but on which we think we have bestowed a better name in calling it "beaded lightning." Since writing the above we learn that this rare phenomenon has been called "*chaplet du feu*," by M. Planté.

THE *Chicago Tribune* is responsible for a statement to the effect that during a recent thunderstorm in that city a little fair-haired girl, Lottie Guild, of four years, had her hair turned from a bright golden hue to blue-black, as well as the scalp of her head blackened, by the action of a lightning discharge down the chimney, which turned her out of her bed and covered her with soot. The hair has been washed in a strong solution of ammonia, but the stain appears to be indelible, although the hair is as silky as ever. This process of hair-dyeing is, we fear, too dangerous to become of general use; but it may well justify some new boon to elderly mankind in the shape of an "Electric and Magnetic hair-wash."

A STARTLING INVENTION.—The genius of America passeth all understanding. We learn that a man in this city (Cincinnati) has invented an automatic cradle so arranged that it is set in motion by the very cry of the infant itself. Mr. Edison's *forte* is automatic contrivances, and we would advise the inventor to say nothing about this invention until it is secured by letters patent. Mr. Edison undoubtedly has published a statement in some paper that he proposed to make a cradle which would operate on the same principle. We are not positive whether the sonorous vibrations produced by the child's voice acts upon a piece of carbon, causes a varying pressure on the same, and thereby affecting an electrical current which operates a mechanical contrivance or not, but in view of the fact that Edison has monopolised the whole field of invention, it is barely possible that this would-be inventor is a base deceiver, guilty of a "straight steal." This man is a German.—*The American Inventor*. [The peculiar advantage of a cradle rocked by the baby's voice is manifestly that the harder the child cried the faster would the cradle rock; a beautiful example of the fitness of things.]

ELECTRICAL APPARATUS FOR EXHIBITING THE ROTATION OF THE EARTH.—Mr. Geo. M. Hopkins, whose electrical gyroscope we illustrated in our number for August 15th, has applied the latter to demonstrate the earth's rotation. For this purpose the gyrating wheel with its electro-magnets is suspended by silk threads in the plane of the meridian, that is at right angles to the plane of the equator and parallel to the polar axis of the earth. The electrical contacts are made by metal discs carried by the wheel dipping into capacious mercury cups carried by the fixed support of the apparatus. A pointer attached to the wheel and a beam of light reflected from a mirror both serve to indicate on a scale the earth's angular velocity.

AT the Parisian electro-plating establishment of the Société du Val d'Osne, a process for coppering cast iron is carried on. The power is derived from steam and transmitted 400 feet by means of electricity in the following manner. The motive shaft drives a Gramme machine, and the current generated is led by wires to a second Gramme machine which is rotated by it. The second Gramme turns a third Gramme which generates the electro-plating current. The velocity is regulated by inserting resistance in circuit.

ELECTRO-TYPING CERAMIC WARE.—A new process for decorating glass and china ware with metallic films has been invented by M. Alexandre. A conducting metallic paste of special preparation is spread over the object, and the design is traced on the glass through this coating. It is then fixed by heating the object in an oven; and when the latter is quite cold it is immersed in the bath and the electro-plate deposited on the glass to the required thickness. The metallic design thus effected can be finished by chiselling or other means.

REACTION OF THE ELECTRIC SPARK IN FORMING PERSULPHURIC ACID.—M. Berthelot, with the view of preparing persulphuric oxide directly from oxygen and sulphur trioxide, passed the electric spark at a high tension through a mixture of the two bodies for some time. The gas in the tube diminished from 60 cc to 40 cc, and the sulphur trioxide was replaced by a body resembling the persulphuric oxide prepared from sulphur dioxide, and which on examination was found to have the same composition, S_2O_7 Persulphuric oxide decomposes slowly when kept, yielding either sulphur trioxide or a mixture of that body with some undecomposed acid. Like ozone and hydrogen dioxide, persulphuric oxide decomposes by degrees when the external energy under the influence by which it is formed ceases.

In the formation of persulphuric oxide, an excess of oxygen is necesssary, otherwise the reaction is incomplete; which fact, according to the author, gives evidence in support of the double action exerted by the electric spark, which is capable of decomposing binary compounds into their elements, and recombining them to form more complex substances, until equilibrium between the decomposition into simple, and the formation of the complex compounds is established. Similar effects have been observed in the action of heat and light on bodies. The equilibrium which attends these syntheses may be explained as the result of the opposition of the two energies (chemical and calorific), the former of which causes the disengagement of large quantities of heat, and the latter

(luminous or electric) being accompanied by the absorption of heat.—*Journal of Chemical Society.*

M. Bartoli has devised an ingenious apparatus for detecting very feeble currents, by causing the invisible bubbles formed on a platinum wire in water when a current is sent through it, to set up a violent ebullition in superheated water.

Interference of Electric Sparks.—M. de Wall, finds that when two electric sparks are simultaneously, produced at the extremities of a short tube smoked inside, the two discharges give figures of interference in the form of a black ring at the middle of the tube. If the sparks are not quite simultaneous the ring is slightly displaced. This method might serve to determine the velocity of sound. It can also be employed to measure the speed of propagation of electricity in a conductor by causing a spark to blaze forth at the middle, and another at the end of a long wire. It would be necessary, however, for this purpose, to obtain complete symmetry at the extremities of the tube, and to ensure that the two waves produced are identical. When the spark is from a battery discharge, the ring examined by microscope, is seen to be formed of several rings due to the oscillating discharge. From the position of these rings, it follows that the partial discharges are separated by an interval of about a quarter of a millionth of a second.

Edison's Carbon Rheostat.—A very neat little rheostat based on the variable resistance of fine plumbago under pressure has been devised by Mr. Edison for quadruplex purposes. It consists mainly of a hollow cylinder of vulcanite standing on a brass baseplate, and containing a pile of fifty circular discs of silk cloth which have been treated by being steeped in sizing, well rubbed with fine plumbago, and then dried. These discs are both elastic and conducting. A metal disc or piston rests on top of them and a vertical screw with graduated head works in the top of the cylinder against the piston. By means of this screw, pressure is applied to the discs, and the degree of compression is indicated on the scale of the screw head by an index. According to the well known principle, an increase or decrease of pressure on the prepared discs is followed by a diminution or augmentation of their resistance as the case may be. By suitable terminals the current is sent through the whole pile. It is stated by the *Scientific American* that the resistance may in this way be varied from 400 to 600 ohms. It appears to us that the principal merit of the contrivance is the fine graduation of resistances it admits of.

Dilatation of Magnetised Cores. — Messrs. Andrew and David Gray, of the Physical Laboratory, Glasgow University, have applied Edison's micro-tasimeter to the measurement of the lengthening and shortening of a bar of iron produced by magnetisation and de-magnetisation. The magnetic effect was produced by the current from three of Thomson's Tray Daniell cells, sent through a rough electro-magnet, formed of four layers of six turns each of insulated wire surrounding a tube containing the iron wire to be magnetised. A deflection of fifty divisions on the sensitive scale of a reflecting galvanometer in the Wheatstone Bridge circuit indicated the elongation on magnetisation. Further results of a quantative kind are promised.

Electric Resistance of Mercury on Heating.—Herr J. Rink, from experiments on seven one-metre long columns of mercury finds the co-efficient for increase of electric resistance due to heat to be 0·000989 for each degree Celsius.

Electricity and the Camera.—It is an advantage in taking photographs to be able to expose the sensitive plate to the object at the proper moment, without going near the camera for that purpose. This is especially the case when photographing babies who are alive to the conspiracy going on about them. Mr. Cowen of Porchester Terrace, Southport, has devised a simple means whereby the shutter of the camera can be opened edgewise by means of a small battery—the contact being closed by a press-button in the operator's hand. A constant battery fitted in a box is set on the camera-stand, and is so small as not to interfere with the portability of the apparatus. The makers of this patented appliance are Messrs. Cusson and Co., Southport.

We also hear from the star-shooting side of the Atlantic that a Californian photographer, Mr. E. J. Muybridge, has, by means of a series of cameras standing 1 ft. apart, and operated by electricity, succeeded in taking negatives of every phase of the action of a trotting horse in taking a complete stride. The means whereby this experiment was effected are more apparent to us than its object; but we suppose it has its own importance for lovers of fast-trotting. The various phases of the complete stride combined in the magic-lantern would, no doubt, furnish a rare treat for the horsey man.

Electricity and the Loom.—Many different kinds of "stop-motions" have been introduced into textile machinery for the purpose of stopping the loom automatically, when, from some cause or other, such as the breaking of a yarn, it begins to perform its work improperly. These purely mechanical contrivances are all more or less delicate, but an electrical stop-motion, not open to this objection, has been invented by Messrs Bullough and Smalley, and applied to the cotton machinery of Messrs. Howard and Bullough, Accrington. The current is supplied by a small magneto-electric machine, weighing a few pounds, and driven by a strap from the main shaft. The current from this machine is so applied that when contact is made by the breaking yarn, or other cause, it traverses an electro-magnet which causes a soft iron armature to drop into a ratchet wheel, whose motion being impeded, makes the strap work upon the loose pulley, and thus stops the machine. This stop-motion is applied to the carding engine, the drawing frame, and a roving frame. In the drawing frame the insulating property of dry cotton is taken advantage of in closing the circuit This invention is giving great satisfaction to the cotton spinners of Lancashire. A full account of it was recently read before the Scientific and Mechanical Society of Manchester by Mr. W. H. Bailey.

We illustrate in this issue the electro-magnetic "crown telephone" of Mr. Phelps, which is used in America as a receiver to Edison's transmitting telephone.

By a recently concluded agreement, the directors of the Eastern Extension Australasia and China Telegraph Company, have practically decided to duplicate the cable between Port Darwin and Singapore. The South Australian Government, on their part, has undertaken to put into thorough working order the land line between Port Darwin and Port Augusta. The concurrence of the New Zealand Government has yet to be obtained before the scheme is finally settled, but there seems but little doubt that there will be any difficulty on this point.

Messrs. Newburg and Co., of Vienna, propose to coat metals with tin by the electrotype process, employing a chromic acid battery for the purpose. The bath in which the articles to be tinned are immersed contains a solution of protochloride of tin and cream of tartar. The deposit being of a dead nature the articles are held over a fire after the electro deposit has taken place, and this gives them a lustrous appearance.

Mr. Adolph C. Wengel, of New York, has devised a method of overcoming the difficulty that attends the operation of making plates of pure nickel for battery anodes. For this purpose he employs ordinary grain metal, and this is held in a flat box of carbon perforated with holes, so that the solution in which this box is immersed comes in contact with all the grains of nickel whilst these grains are all in electrical connection with the pole of a battery through the medium of the carbon box which is itself connected to the battery.

The form of sounder devised by Mr. Elisha Gray, of Chicago, has been adopted for use by the Postal Telegraph Department.

M. Cochery, the director of the French postal telegraphs, is now in London with the view of introducing any improvement in the French service which may be suggested to him by the working of the English telegraph system.

Lloyd's agent at Singapore, in a telegram dated September 24th, reports that the telegraph steamer *Edinburgh*, belonging to the Eastern Extension, Australasian, and China Telegraph Company, had gone ashore near that place, but was likely to be got off without damage.

A course of lectures on Experimental Physics, including the Elements of Telegraphy and Electrical Measurements, will be held at the Birkbeck Literary and Scientific Institution by Mr. W. J. Wilson, F.C.S., M.S.T.E., commencing October 4th.

The South Eastern Railway Company have now fitted to all their trains electrical communication between passengers and guards, the system being that devised by Mr. C. V. Walker. We learn the Brighton Company are also following the example of their neighbours by fitting up a similar apparatus on their own line.

Mr. Wilde, of Manchester, has, we hear, received a second order from the Admiralty for electric light apparatus.

New Patents.

3134. "Apparatus for the dynamical production and application of electricity, and for its regulation when applied for illumination."—C. H. Siemens (communicated by E. W. Siemens and F. H. Von Alteneck). Dated, August 8.

3217. "An improved method of and apparatus for the transmission of signals by electricity between railway trains and stations, or other parts of the line, and for similar purposes."—W. R. Lake (communicated by A. Cattaneo). Dated, August 14.

3250. "Producing and regulating electric light."—H. Wilde. Dated August 17.

3315. "Apparatus for electric lighting."—C. W. Siemens. Dated, August 22.

3317. "Galvanometers."—E. A. Obach. Dated August 22nd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

4468. "Apparatus for the electric transmission of telephonic communications."—L. M. de Bejar y O'Lawlor. Dated, November 27, 1877. 6d. This consists in combining the speaking telephone with the "Auto-kinetic" system (patented by Alexander Brown, No. 2327, 1873, and L. M. de Bejar, O'Lawlor, and N. A. Calvo, No. 1303, 1876), whereby one wire serves to convey a number of telephone messages from separate points to one central station.

4893. "Dynamo-electric and magneto-electric machines." A. M. Clark (communicated by Lontin & Co., Paris). Dated, December 24, 1877. 4d. This consists in a dynamo-electric machine which dispenses with commutators or collectors by the circular motion of a coil between two similar magnetic poles producing four currents all in the same direction. This is effected by causing the coil, when receding from a pole, to be completely reversed so as to present to the said pole the opposite end to that which it presented on approaching the latter.

4934. "Electric Telephony."—Charles Weightman Harrison. Dated, December 29. 6d. This consists of making speaking telephones out of thermopiles, on which the warmth of the breath plays in speaking; and also out of a battery circuit, in which there is a breach filled up by a liquid or other resistance capable of being varied under pressure of the air vibrations; these vibrations being directed against the electrode (which may be flat or curved surfaces) dipping into the intercalated conductor. Curiously enough, figure 4 of this patent describes an adjustable microphone in everything except the battery, which is left out under the impression that being a thermopile no battery would be necessary, since the warmth of the breath would work it. An interesting point about this patent is the description and illustration of a form of carbon microphone, adjustable and actuated by a carbon zinc pile, with a sheet of cloth moistened with saline solution between the plates. An upright plate of carbon rests its lower end in a groove cut across the upper surface of the carbon plate of the pile, and is adjusted by a screw. In fact, it is a sort of portable microphone, such as is sold by Mr. Lancaster, the instrument maker. The author of this patent shows that he was unaware how nearly he had come to making a great discovery. The patent continues: My invention relates thirdly, to the employment of flat or other spirals or coils of wire attached at each end, or at stations on the line wire. The words to be conveyed are spoken on to one or more of these coils and received at the other end by similar coils. The coils may be employed with or without a local battery. Sometimes the coils are made a source of electricity by being constructed compound, *i.e.*, of more than one metal; or by coating them with magnetic sand, or by other suitable means. In my experiments I have found that the conducting wire of the circuit will produce sonorous vibrations in accordance with the variations in the current. For this purpose, I prefer that the spiral should be of soft iron, and that it should be stretched over a sounding board with a moderate degree of tension. The spiral is supported at its nodal points; in order to converge the sound upon them a trumpet mouthpiece may be placed over them. The spirals have been found suitable for placing in circuit with a standard clock, and thus serving as chronophones for repeating the hour in different places. The receiver is electro-magnetic—the diaphragm being

as thin as possible at the centre and increasing to seven or eight times its central thickness at the circumference. The north pole of the magnet is arranged opposite the centre of the disc, and the south pole at the margin. When it is desired to keep a record of the sounds, a means of indenting them on a moveable surface is provided.

General Science Columns.

The Detection of Fire-Damp. — Professor G. Forbes, of Glasgow, brought before the Mathematical and Physical Section an ingenious and novel device for detecting the presence of fire-damp in coal mines. Nothing could be simpler than the plan proposed by Professor Forbes; simply a tuning-fork of definite pitch, vibrating before a resonant tube, the loudness of the resonance depending on the nature of the gas with which the tube is filled; so that when fire-damp replaces the air in the tube, the resonant tube must be lengthened, inasmuch as the velocity of sound is greater in fire-damp than in air, and the amount of lengthening indicates, with proper precautions, the approximate amount of fire-damp present. The resonator is a metal tube, one inch diameter and fifteen inches long, in which a piston slides so as to regulate the length of the tube. The tube is fixed to a block of wood, to which is attached a tuning-fork, the prongs of which are just above the open end of the tube. The tuning-fork is sounded in any convenient way, and the piston is moved out and in until the proper length is found, which is indicated by the resonator intensifying the sound of the tuning-fork. With practice, the precise length can thus be tetermined with an accuracy of at least one in 250. But the length depends on the density of the gas—a light gas requiring a longer resonator, and by reading off on a scale the position of the piston a person can judge of its density. In this manner one or two per cent. of fire-damp mixed with common air can be detected. Barometric pressure produces no difference on the instrument. The temperature correction is made by reading off a thermometer whereon are marked the necessary corrections. The only error is by the presence of dense carbonic acid gas. But carbonic acid gas tends to destroy the explosive character of fire-damp, and it appears that if the presence of carbonic acid prevented the instrument from indicating fire-damp it would certainly be sufficient to prevent the explosive character of the fire-damp.

An electric arrangement to maintain the vibration of the fork, and thus at once to announce a change in the character of the atmosphere in the mine, would be a useful adjunct to this invention. We doubt, however, whether any contrivance of this kind suggested by Professor Forbes will be likely to come into use in coal mines; to a careful miner the change in the aspect of the flame of his Davy lamp is a sure warning of an influx of fire-damp, and to a careless miner no warning is of any avail. A more striking and more sensitive test of the presence of fire-damp was proposed some time ago by Professor Barrett, being founded on his discovery of the change in colour produced in a hydrogen flame by its contact with certain bodies. Carbonic acid gas and fire-damp give a characteristic colouration to the flame of pure hydrogen, and so marked and delicate is this re-action, that, as a rapid qualitative test, it might often be applied by the chemist. As regards its detection of carbonic acid gas, Professor Barrett's test would be a boon to stifling audiences in theatres and elsewhere if an Act of Parliament compelled the windows to be opened on the first signal given by the flame.

During the meeting of the British Association' the Lord Lieutenant visited Mr. Grubb's famous astronomical works in Rathmines. It will be remembered that at these works were constructed the great Melbourne Telescope, and the several large equatorials lately erected in England for the Royal Society for Lord Lindsay for Oxford University, &c. Mr. Grubb has now in construction the largest refractor ever attempted. This instrument is 27 inches clear aperture, and will ultimately be erected at the new Imperial Observatory in Vienna. For this institution Mr. Grubb is also making the necessary domes and machinery: three great domes, each as large as that in the Greenwich Observatory, have already been dispatched, and the huge steel dome, 45 feet in diameter, which is to surmount the Great Equatorial Room in Vienna, is now complete, and ready for transit. This is the largest observatory roof in the world, and when we remember that it is necessary that this ponderous roof of 15 tons weight must be moved round and manipulated with one hand, the nature and difficulties of the work may be appreciated. A few years since almost all astronomical instruments were obtained from Germany; the last few years have seen the creation of an astronomical manufactory in Dublin employing exclusively Irish workmen, and competing successfully against foreign manufacture, outstripping not only the astronomical works of England, but even those abroad, which formerly supplied all such instruments to the world; the last few years having seen more than £15,000 worth of astronomical instruments manufactured for Germany alone.

Wheatstone's Microphone. — *History.*—Upwards of fifty years ago the name microphone was given to an instrument by Sir Charles Wheatstone, in a paper entitled "Experiments on Audition," published in the *Quarterly Journal of Science* for 1827. In this paper Wheatstone remarks:—"The great intensity with which sound is transmitted by solid rods, at the same time that its diffusion is prevented, affords a ready means of affecting this purpose [the augmentation of external sounds], and of constructing an instrument which, from its rendering audible the weakest sounds, may with propriety be named a *microphone*" It must be borne in mind, continues the distinguished author, that "the microphone is only adapted for hearing sounds when it is in immediate contact with sonorous bodies; when sounds are diffused by their transmission through the air the instrument will not afford the slightest assistance."

Hughes' Microphone.—It is perhaps needless to remark that the electric microphone, discovered this year (1878) by Professor Hughes, has nothing in common with the foregoing instrument except its delicacy in the detection of feeble sonorous vibrations in solid or liquid bodies.

In Hughes' microphone an electric circuit must be made from some voltaic cell through a fragment of carbon, resting on another fragment, and to an attached telephone, which may be miles away; under such circumstances any slight movements communicated to the carbon microphone—even such as are not sonorous—produce fluctuations in the strength of the electric current which are instantly revealed by an audible quivering in the disc of the telephone. In Wheatstone's microphone, electricity plays no part, the sonorous vibrations are transmitted by conduction along the metal rod to the ear, and reach the auditory nerve chiefly by conduction through the bones of the skull, and only in part by the ordinary channel of hearing, namely, the external meatus, tympanic membrane, &c.

Experiments.—Numerous experiments with this simple instrument will suggest themselves, but the following

among others suggested by Professor Barrett, cannot fail to be successful. In every case *place the cups one on each ear, and let the point depend*:—

1. Draw the feather of a quill over the point, every motion of the feather will be loudly heard. Try the same experiment when the cups are not on the ears, nothing can be heard.

2. Gently tap the point with a penholder or pen knife, a deafening sound will be heard.

3. Place the point on the face of a watch, the ticking of the watch will be distinctly heard, or the watch may be placed at the end of a long wooden or metal rod—on an iron fence, for example—and the ticking will thus be heard through a great length of conducting material.

4. Press the point against the sides of a kettle of water at or near boiling; the ebullition of the water will be heard with surprising loudness.

5. In like manner the falling of coarse sand through a sand glass may be heard, or the movement of water through the water pipes when a distant tap is opened.

6. Enclose one or two flies in a match box, and gently touch the box with the point of the microphone; the crawling of the flies will be distinctly heard. If a blue bottle fly be enclosed, and the box slightly opened, but not so far as to permit the escape of the prisoner, the efforts of the fly to release itself will be loudly heard, together with every separate kick given by the little prisoner against the walls of its prison.

7. That a large part of the sound heard is transmitted by conduction through the bones of the skull, and not through the mechanism of the organ of hearing, may be proved by fixing the cups of the microphone on each side of the head, just above or below the ear, the scraping of a feather on the instrument will still be heard, but not quite so loudly as before.

8. Again, a small tuning fork when struck, and the stem placed anywhere on the head, will be heard loudly. If both ears be stopped by the fingers, the fork will be heard much louder, and if one ear be unstopped the fork will appear to sound in the ear that is *stopped*, although it may be held quite close to the unstopped ear. Wheatstone notices this, and the cause probably arises from the resonance or sympathetic vibration of the air within the closed cavity of the ear, producing thereby a reinforcement of the sound on that side.

9. A striking experiment on the conduction of sound may be made by tying the knob of an ordinary poker to the centre of about a yard of tape; on holding the ends of the tape tightly against each ear, and so freely suspending the poker, a simple Wheatstone's microphone may be made. Gently striking the poker and allowing it to ring, a sound will be heard resembling the deep booming of the great bell of St. Paul's.

10. Wheatstone's microphone may be employed in the investigation of the state of sounding bodies; the position of nodal surfaces and ventral segments in organ pipes and other acoustic instruments may be searched out.

The following experiments are given by Wheatstone himself:—

11. If a bell be rung in a vessel of water and the point of the microphone be placed in the water at different distances from the bell, the difference of intensity will be very sensible.

12. If the point of the microphone be applied to the sides of a vessel containing a boiling liquid, or if it be placed in the liquid itself, the various sounds which are rendered may be heard very distinctly.

13. The instrument affords a means of ascertaining, with considerable accuracy, the points of a sonorous body at which the intensity of vibration is the greatest or least; thus placing its point on different parts of the sounding-board of a violin or guitar whilst one of its strings is in vibration, the points of greatest and least vibration are easily distinguished.

14. If the stem of a sounding tuning-fork be brought in contact with any part of the microphone, and at the same time a musical sound be produced by the voice, the most uninitiated ear will be able to perceive the consonance or dissonance of the two sounds; the roughness of discords and the beatings of imperfect consonances are thereby rendered so extremely disagreeable, and form so evident a contrast to the agreeable harmony and smoothness of two perfectly consonant sounds, that it is impossible that they can be confounded.—*Quarterly Journal of Science*, 1827, Part II.

The Para and Ceara Rubbers.—We are indebted to the *Journal of the Society of Arts* for the following new information about the Para and Ceara rubbers, which has been derived from the report of Mr. Robert Cross to the Secretary of State for India. Mr. Cross calls attention to the gnarled and warty state of the base of rubber trees, caused by the method of milking the trees, by cutting into the trunk with a hatchet, so as not only to pierce the bark, but the wood itself, a proceeding quite unnecessary since the juice flows between the wood and bark. The gashed wood heals again, but only at the expense of the bark, which is thinner over the wound, and the general vitality of the tree. The result is that the flow of milk year after year becomes lessened, and in a few years the tree dies in its prime. This evil once recognised can, however, be remedied. A moist, deep, heavy, fertile soil, but not necessarily inundated at any season of the year, is that best adapted for the rubber tree. There seems to be no appreciable difference in the quality of the rubber, whether collected in the dry or in the rainy season. It may be, however, that in the wet season a larger proportion of water is contained in the caoutchouc, while on the other hand a larger quantity of milk flows. The dry season is, in fact, the most suitable for caoutchouc collecting. The drying of the rubber juice in the smoke of burning palm seeds (which are said to be those of the *Euterpe Edulis* and a species of the *Attalea*) has given rise to an opinion, always stated by travellers, that the smoke produced by these burning nuts exercises some peculiar effect upon the milk, by which it coagulates almost instantly. After a careful examination of this matter, Mr. Cross expresses it as his conviction that the rapid coagulation of the milk is simply produced by the high temperature of the smoke, and that with a strong current of heated air, or a good pressure of steam from a pipe, a similar result would be obtained. He says: "I have no hesitation in giving my opinion that an equally good rubber could be prepared by putting the milk into shallow vessels, and evaporating the watery particles by the heat of boiling water." Mr. Cross brought home seeds and plants of the true Ceara rubber, which is now proved to be the produce of *Manihot glasiovii*, a plant distinct from the Para rubber tree, but a member of the same family—the Euphorbiaceæ. Ceara rubber is collected in a manner different to Para rubber. The outer surface of the bark of the trunk is pared off to a height of four or five feet; the milk then exudes and trickles down in an irregular manner, falling, for the most part, on to large leaves that are laid about the base of the trunk to receive it; some, however, often drops on to the ground, and so often gathers up with it dust and loose stones. After several days the juice becomes dry and solid, and is then pulled off and rolled up into balls, or put into bags in loose masses. The trees are badly treated, the tapping being made too deeply in the wood, so that

many trees are in a state of decay. From the fact that Ceara rubber occupies a good place in the market, being exported at the rate of about 1,000 tons per annum, it is to be hoped that more care may be taken of the trees, and that it may be successfully established in India. Mr. Cross recommends the hottest, low-lying, moist tracts of the Malay peninsula, Burmah, Ceylon, and Southern India for the Para rubber tree, and the districts of Madras, Cochin, Calicut, Cannanore, Mangalore, Bombay, and, indeed, all the parched regions of India within the limits of coffee culture, for the Ceara tree.

A COMPANY has been formed, under the presidency of Senator Pierce, for the purpose of transmitting some of the water power of Niagara, by means of compressed air, to the city of Buffalo, a distance of twenty-two miles. It is calculated that power sufficient to raise 350,000 gallons of water 150 feet will be obtained per minute by this plan, a power capable of working all the mills and factories in Buffalo.

City Notes.

Old Broad Street, September 27, 1878.

AT the tenth half yearly general meeting of the Direct Spanish Telegraph Company, held on the 26th inst., the Chairman, in moving the adoption of the report, an abstract of which was given in our last issue, said that the shareholders would hear with satisfaction that the cables of the company were in the same high electrical condition as at the time of the last report; and in the reports which they had since had from their electrician, the condition of the cables was stated to be as satisfactory as ever. He was glad to say that the hopeful signs of a revival of business in Spain, which had begun to manifest itself in increased receipts from the beginning of August, had continued, and had resulted in the month of September to a considerable further increase. Last year the receipts for September were £812 0s. 7d., and so far as they could judge from the days which had expired of the present month, their receipts would be over £1,000, showing an increase of more than 25 per cent. They did not like to prophecy as to the future, but still they were just at the beginning of the fruit season, the prospects of which were very good this year in Spain. As he had said the receipts for this month would be over £1,000, and supposing they averaged £1,000 a month for twelve months, they would be able to pay their preference dividend in full, put £700 to reserve, and pay 2s. a share on the ordinary shares; while a further increase of £50 a week for twelve months would enable them to put £1,800 to reserve and pay 4s. a share on the ordinary shares. The expenditure was about the same as usual.—Mr. Abraham Scott, a director, having seconded the motion, it was carried unanimously, and the dividend on the preference shares was declared. The usual complimentary vote closed the proceedings.

The directors of Reuter's Telegram Company (Limited) have declared an interim dividend at the rate of 5 per cent. per annum per half year ending June 30 last.

The Eastern Extension, Australasia, and China Telegraph Company (Limited) have declared an interim dividend for the quarter ended June 30, of 2s. 6d. per share, or at the rate of 5 per cent. per annum, payable on the 15th October.

At a meeting of the directors of the West India and Panama Telegraph Company (Limited), after deciding to place £5,000 to reserve, it was resolved to recommend to shareholders at the approaching meeting that a dividend at the rate of 1 per cent. per annum (free of income tax), on the ordinary shares of the company, be declared for the half-year ending June 30, 1878, in addition to the dividend at the rate of 6 per cent. per annum on the first and second preference shares of the company.

At a meeting of the board of directors of the Anglo-American Telegraph Company, held this day, it was resolved, after reserving £37,500 for the renewal fund, to declare an interim dividend for the quarter ending September 30 of 1¼ per cent. on the Consolidated Stock, and 2 per cent. on the Preferred Stock, leaving about £10,000 to be carried forward. The transfer books will be closed from the first to the 4th proximo.

The Great Northern Telegraph Company notified on September 20th that, owing to a typhoon, the Company's cables between Nagasaki and Shanghai and between Shanghai and Amoy are interrupted. The repairing steamer being on the spot, a speedy restoration is expected. Meanwhile, messages for Hong Kong and Amoy cannot be accepted, and messages for Shanghai will be forwarded from Nagasaki by steamer. The Company's lines to all Japanese stations work well. Since the above notification was issued, a service has been received from Shanghai. This message was sent from the repairing ship to Nagasaki, and it is therefore expected that the final splice of the cable will soon be effected.

The Eastern Extension Telegraph Company notify that their cable between Java and Australia is interrupted. Telegrams for Australia and New Zealand will be forwarded between the interrupted points until communication is restored by the special steamer chartered by the Australian Governments.

The steamship *Great Northern* has recently left Gravesend with about 500 miles of submarine cable on board for the purpose of connecting Cyprus telegraphically with Beyrout and with the Eastern Telegraph Company's cable at Alexandria.

The following are the late quotations of telegraphs:—Anglo-American, Limited, 61-61½; Ditto, Preferred, 90-91; Ditto, Deferred, 34½-35; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6¾-7; Cuba, Limited, 9¼-9¾; Cuba, Limited, 10 per cent. Preference, 15¾-16¼; Direct Spanish, Limited, 2-2½; Direct Spanish, 10 per cent. Preference, 9¾-10¼; Direct United States Cable, Limited, 1877, 13-13¼; Eastern, Limited, 7¼-7½; Eastern, 6 per cent. Debentures, repayable October 1883, 107-110; Eastern 5 per cent. Debentures repayable August, 1887, 99-101; Eastern 6 per cent. Preference, 11½-11¾; Eastern Extension, Australasian and China, Limited, 7¼-7½; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; German Union Telegraph and Trust, 8-8½; Globe Telegraph and Trust, Limited, 5⅛-5⅜; Globe 6 per cent. Preference, 10⅞-11⅛; Great Northern, 8-8¼; Indo-European, Limited, 20-21; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 9½-10; Reuter's Limited, 10-11; Submarine, 216-221; Submarine Scrip, 1⅞-2⅛; West India and Panama, Limited, 2-2¼; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited, 3-3½; Ditto, 6 per cent. Debentures "A," 93-96, Ditto, ditto, ditto, "B," 91-93; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds; 114-118; Ditto, 6 per cent. Sterling Bonds, 99-101; Telegraph Construction and Maintenance, Limited, 31¼-31¾; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅝-2⅞.

THE TELEGRAPHIC JOURNAL.
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GAS v. ELECTRIC LIGHTING.

THE most important practical scientific question of the hour, and the one of greatest public interest, is that of illumination by means of electricity. Every day the subject is developing and attracting more and more attention. As we predicted long ago, the Paris Exposition, and the fine display of the power and beauty of the electric arc which has been this year made patent to all the world in that city, have given an incalculable impetus to the progress of this mode of lighting. It has been said, doubtless by some timid holder of gas shares with whom the wish was father to the thought, that with the Paris Exhibition so would the electric light pass away again, and sink into the darkness from whence it sprung; but there is now no fear of that. It has made too great an impression on the public mind, and gained too widespread a footing for itself in practical usage now, to lapse into obscurity. Inventors, too, are giving their ingenuity to the solution of the difficulties which still bar its advancement, a great many patents relating to it are being taken out in all civilised countries, it is one of the present tides in the affairs of men which may lead to fortune—in short "there is money in it," and its ultimate success is undoubted.

It has hitherto been the habit of gas investors to dread, and of gas directors to repudiate, the electric light as a promising rival of gas. It would seem indeed as if colour blindness was unusually common amongst the directors of gas companies, for few of these gentlemen have been able to see the superior excellence of the electric light over gaslight. To them it has appeared a weird ghastly glow, reminding them of corpse-lights and mortal decay. If it be true that gas directors are particularly subject to jaundiced vision, a philosophic oculist might, with some show of reason, attribute the fact to the meretricious influence of the yellow gaslight they have been so long habituated to. From recent meetings, however, we are happy to see that a change has taken place in the attitude of the leading London gas companies towards the new illuminator. It is no longer pooh-poohed by them, but wisely regarded as a declared rival, which must be fairly competed against if gas-lighting is to hold its ground. The cost of electric lighting for street purposes is at present so much more than gas that, although the superiority of the light is unquestionable, there will be no hurry to supersede gas by it. But even if all the streets of the metropolis were lit by electricity, we are told that it would only cause a reduction of about 1 per cent. on the gross revenues of the companies who get their principal receipts from domestic lighting. If this be so, there is no immediate cause for a panic among gas shares, and gas shareholders may use the statement as a prop to their tottering faith. But we would advise them not to trust too implicitly to consolation of this kind.

It is true that at present an invention, by which the electric current supplying the electric lamps can be subdivided so as to feed a great many light centres, and thus at the same time moderate while it distributes the light, is a desideratum necessary to the complete success of electric lighting even for general street purposes, let alone household uses. But tried inventors are at work on the problem, and any day may see its accomplishment. Some comfort may be derived from reflections that gas lighting will never be driven from the field, that gas will be more and more used for heating purposes, that it will even be used in gas engines for generating powerful electric lights, and that at least for many years to come it will keep its impregnable position as a domestic illuminator. But at the same time it should not be forgotten that an invention may come any day which will dispel these dreams of security, and banish gas lighting to a secondary place. In proof of this we have only to cite the report from America (published on another page) that the indefatigable Mr. Edison has succeeded in solving the problem of general electric illumination in the most thorough and sweeping manner. While the gas companies were in the act of laying the soothing unction to their souls, and congratulating themselves on their safe position even against electric street lighting, the news was being flashed across the Atlantic that Edison had invented a means of subdividing the electric current indefinitely, so as to produce 1,000 lights if need be from one machine, and of bringing it into homes for household purposes, such as lighting, heating, and driving sewing machines, at half the cost of gas and without disturbing the existing brackets and chandeliers.

The Napoleon of invention delights in startling surprises, and his fertile and daring imagination runs at once through the whole gamut of possibilities as soon as the key-note of a new idea is struck. Future developments are to him as if they already existed; but for all that the great mechanical genius of Mr. Edison is so well attested, that any report of the kind is to be taken seriously. It is a sign of the uncanny reputation of this inventor, that on the publication of the said announcement in London on

October 8th, the gas shares fell seven per cent. No opinion can be passed on the merits of the new invention until a description of it is made public, which will not be until the patents are secured. Meanwhile, both inventors, gas shareholders, and the general public will be interested to learn what the coming disclosure is to be. We trust that Mr. Edison, for his own as well as others sake, has made himself certain of the success of his invention before sending forth the telegrams proclaiming it. It is a fine thing, no doubt, to assume the god and shake the spheres with a nod; but it must not be forgotten that the disturbance may cost heavily to humbler beings. In conclusion, we would remark that the announcement that the problem of dividing the light has been completely solved by Mr. Edison need not deter other inventors from giving their minds to this matter. We have yet to learn what the new system is, and although Mr. Edison is admittedly a great inventor, he cannot be supposed to monopolise all ideas on the subject, nor even always to hit upon the best.

EDISON'S ELECTRIC LIGHT.

INFORMATION reached this country on Monday, October 7, stating that Mr. Edison, the inventor of the phonograph, had succeeded in dividing the electric light, so as to apply it to the existing gas fixtures, at a considerable reduction in cost. The same communication was made to the American Commissioners at the Paris Exhibition, and through them made known in London. On the news of this discovery becoming known, a heavy fall in the value of gas shares took place. The following description of Mr. Edison's invention is taken from the *New York Sun*:—

"Mr. Edison says that he has discovered how to make electricity a cheap and practicable substitute for illuminating gas. Many scientific men have worked assiduously in that direction, but with little success. A powerful electric light was the result of these experiments, but the problem of its division into many small lights was a puzzler. Gramme, Siemens, Brush, Wallace, and others produced at most ten lights from a single machine, but a single one of them was found to be impracticable for lighting aught save large foundries, mills, and workshops. It has been reserved for Mr. Edison to solve the difficult problem desired. This, he says, he has done within a few days. His experience with the telephone, however, has taught him to be cautious, and he is exerting himself to protect the new scientific marvel, which, he says, will make the use of gas for illumination a thing of the past. While on a visit to William Wallace, the electrical machine manufacturer in Ansonia, Connecticut, he was shown the lately perfected dynamo-electric machine for transmitting power by electricity. When power is applied to this machine it will not only reproduce it, but will turn it into light. Although said by Edison to be more powerful than any other machine of the kind known, it will divide the light of the electricity produced into but ten separate lights. These being equal in power to 4,000 candles, their impracticability for general purposes is apparent. Each of these lights is in a substantial metal frame, capable of holding in a horizontal position two carbon plates, each 12in. long, 2½in. wide, and ½in. thick. The upper and lower parts of the frame are insulated from each other, and one of the conducting wires is connected with each carbon. In the centre, and above the upper carbon, is an electro-magnet in the circuit, with an armature, by means of which the upper carbon is separated from the lower as far as desired. Wires from the source of electricity are placed in the binding posts. The carbons being together, the circuit is closed, the electro-magnet acts, raising and lowering the upper carbon enough to give a bright light. The light moves towards the opposite end from which it starts, then changes and goes back, always moving towards the place where the carbons are nearest together. If from any cause the light goes out the circuit is broken, and the electric magnet ceases to act. Instantly the upper magnet falls, the circuit is closed, it relights, and separates the carbon again. Edison on returning home after his visit to Ansonia studied and experimented with electric lights. On Friday, October 4, his efforts were crowned with success, and the project that has filled the minds of many scientific men for years was developed. 'I have it now!' he said, on Saturday, while vigorously turning the handle of a Ritchie inductive coil in his laboratory at Menlo Park, 'and, singularly enough, I have obtained it through an entirely different process than that from which scientific men have ever sought to secure it. They have all been working in the same groove, and when it is known how I have accomplished my object, everybody will wonder why they have never thought of it, it is so simple. When ten lights have been produced by a single electric machine, it has been thought to be a great triumph of scientific skill. With the process I have just discovered I can produce 1,000—aye, 10,000—from one machine. Indeed, the number may be said to be infinite. When the brilliancy and cheapness of the lights are made known to the public—which will be in a few weeks, or just as soon as I can thoroughly protect the process—illumination by carburetted hydrogen gas will be discarded. With 15 or 20 of these dynamo-electric machines recently perfected by Mr. Wallace I can light the entire lower part of New York city, using a 500-horse power engine. I purpose to establish one of these light centres in Nassau Street, whence wires can be run up town as far as the Cooper Institute, down to the battery, and across to both rivers. These wires must be insulated, and laid in the ground in the same manner as gas pipes. I also propose to utilise the gas burners and chandeliers now in use. In each house I can place a light meter, whence these wires will pass through the house, tapping small metallic contrivances that may be placed over each burner. Then housekeepers may turn off their gas and send the meters back to the companies from whence they came. Whenever it is desired to light a jet it will only be necessary to touch a little spring near it. No matches are required.' 'Again, the same wire that brings the light to you,' Mr. Edison continued, 'will also bring power and heat. With the power you can run an elevator, a sewing machine, or any other mechanical contrivance that requires a motor, and by means of the heat you may cook your food. To utilise the heat it will only be necessary to have the ovens or stoves properly arranged for its re-

ception. This can be done at trifling cost. The dynamo-electric machine, called a telemachon, and which has already been described, may be run by water or steam power at a distance. When used in a large city the machine would of necessity be run by steam power. I have computed the relative cost of the light, power, and heat generated by the electricity transmitted to the telemachon to be but a fraction of the cost where obtained in the ordinary way. By a battery or steam-power it is 46 times cheaper, and by water-power probably 95 per cent. cheaper.' It has been computed that by Edison's process the same amount of light that is given by 1,000 cubic feet of the carburetted hydrogen gas now used in this way, and for which from 2 dollars 50 cents to 3 dollars is paid, may be obtained for from 12 to 15 cents. Edison will soon give a public exhibition of his new invention."

THE ELECTRIC LIGHT IN SHOPS.

The first instance of the application of the electric light to the illumination of a retail business establishment in the metropolis took place last evening on the premises of the London Stereoscopic Company, in Regent Street. Having made use of the electric light for photographic purposes, the Company thought they might as well avail themselves of electric power as a source of light instead of gas. In the basement of the building is an Otto silent gas engine, capable of working up to eight horse-power. In order to generate the electric light the engine is worked up to a power of five horses, the outlay for which is reckoned at 5d. per hour. This engine drives a shaft at the rate of 750 revolutions per minute, working one of Siemens' dynamo-electric machines, from whence the current is conveyed to a lamp suspended from the facia over the shop front, the lamp being fitted with one of Siemens' automatic regulators, a magnet being brought into play to keep the carbon points at the requisite distance from each other. The cost of maintaining the light, including the 5d. per hour for the five horse-power of the gas engine, is stated to be 7d. per hour. The light is reckoned as equal to 4,000 sperm candles. The lamp takes the place of ten powerful argand burners previously used to illuminate the shop front, which is of considerable length as well as height. As may be supposed, the electric light far exceeds in volume and intensity the amount of illumination obtained from the ten argand gas burners. The trial last night was to some extent experimental, and there was considerable unsteadiness in the light—a circumstance attributed to the wind which blew at the time, the interior of the lamp being imperfectly protected from the blast. The lamp was globular in form, with ground glass for the transparent medium. The effect of the light was very good, the coloured photographs in the window exhibiting their proper colours as in daylight. There was nothing either ghastly or ghostly in the appearance of the passers by as they traversed the flood of radiance which fell on the footway. But the gaslights decidedly suffered, and presented a dismal appearance, the street beyond the range of the electric rays looking as if plunged in some unusual gloom. The general effect differed somewhat from that which is observable at the Gaiety Theatre, where the Lontin light is exhibited, the light in Regent Street being whiter, with a tinge of violet. Some difference in the transparent medium is perhaps the cause, or it may be that the Siemens' light is stronger than the Lontin. The Siemens' lamp requires a renewal of the carbons at the end of three hours, but that extent of duration is sufficient for an establishment which adopts the early closing principle. Fresh carbons can be inserted in about three minutes, or less. If a second lamp be provided the current can be diverted from one point to the other in a couple of seconds. It will be observed that in this case there is no division of lights, the whole of the current flowing to one lamp. With some little adjustment the light promises to answer well, and the experiment of last night was held to be amply satisfactory.—*Standard*, Oct. 9.

A NEW SYSTEM OF ELECTRIC LIGHTING.

By Profs. ELIHU THOMSON and EDWIN J. HOUSTON, of the Philadelphia Central High School.

Having been engaged in an extended series of experimental researches on dynamo-electric machines and their application to electric lighting, our attention has been directed to the production of a system that will permit of the use of a feebler current for obtaining an electric light than that generally employed, or in other words, of using, when so required, a current of insufficient intensity to produce a continuous arc. At the same time our system permits of the use of a powerful current in such a manner as to admit of a considerable number of electric lamps being placed in the same circuit.

As is well known, when an electrical current, which flows through a conductor of considerable length, is suddenly broken, a bright flash, called the extra spark, appears at the point of separation. The extra spark will appear although the current is not sufficient to sustain an arc of any appreciable length at the point of separation.

In our system, one or both of the electrodes, which may be the ordinary carbon electrodes, are caused to vibrate to and from each other. The electrodes are placed at such a distance apart that in their motion towards each other they touch and afterwards recede a distance apart, which can be regulated. These motions or vibrations are made to follow one another at such a rate, that the effect of the light produced is continuous; for, as is well known, when flashes of light follow one another at a rate greater than twenty-five to thirty per second, the effect produced is that of a continuous light. The vibratory motions may be communicated to the electrodes by any suitable device, such for example as mechanism operated by a coiled spring, a weight, compressed air, &c., &c., but it is evident that the current itself furnishes the most direct method of obtaining such motion, as by the use of an automatic vibrator, or an electric engine.

In practice, instead of vibrating both electrodes, we have found it necessary to give motion to but one, and since the negative electrode may be made of such size as to waste very slowly, motion is imparted to it, in preference to the positive. The carbon electrodes may be replaced by those of various substances of sufficient conducting power.

In this system, when desired, an independent battery circuit is employed to control the extinction and lighting of each lamp.

The following is a description of one of the forms of electric lamp which we have devised to be used in connection with our system of electric lighting.

A flexible bar B, of metal, is firmly attached at one of its ends to a pillar P, and bears at its other end an iron armature A, placed opposite the adjustable

FIG. 1.

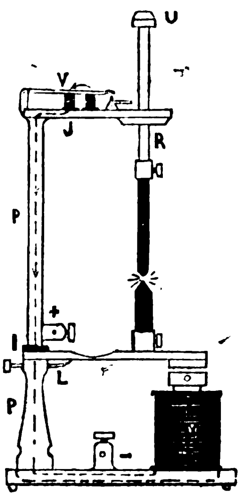


FIG. 2.

pole piece of the electro-magnet M. A metal collar C, supports the negative electrode, the positive electrode being supported by an arm J, attached to the pillar P. The pillar P is divided by insulation at I into two sections, the upper one of which conveys the current from the binding screw marked + to the arm J, and the rod R, supporting the positive electrode. The magnet M, is placed, as shown by the dotted lines, in the circuit which produces the light. The pillar P is hollow, and has a insulated conducting wire enclosed which connects the circuit closer V with the binding post. The current is conveyed to the negative electrode through B and the coils of the magnet M.

When the electrodes are in contact, the current circulating through M, renders it magnetic, and attracts the armature A, thus separating the electrodes, when by the consequent weakening of the current the elasticity of the rod B again restores the contact. During the movement of the negative electrode, since it is caused to occur many times per second, the positive electrode though partially free to fall, cannot follow the rapid motions of the negative electrode, and therefore does not rest in permanent contact with it.

The slow fall of the positive electrode may be ensured either by properly proportioning its weight or by partly counterpoising it. The positive electrode thus becomes self-feeding.

The rapidity of movement of the negative carbon may be controlled by means of the rigid bar L, which acts partially to shorten or lengthen the part vibrating.

In order to obtain an excellent but free contact of the arm J, with the rod R, bearing the positive carbon, the rod, made of iron or other suitable metal, passes through a cavity S, fig. 2, filled with mercury, and placed in electrical contact with the arm J. Since the mercury does not wet the metal rod R, or the sides of the opening through which it passes, free movement of the rod is allowed without any escape of the mercury. It is believed that this feature could be introduced advantageously into other forms of electric lamps.

In order to prevent a break in the circuit occurring when the electrodes are consumed, a button U, is attached to the upper extremity of the rod R, at such a distance that when the carbons are consumed as much as is deemed desirable, it comes into contact with a tripping lever T, which then allows two conducting plugs attached to the metal bar V to fall into their respective mercury cups, attached directly to the positive and negative binding posts respectively. This action serves practically to cut the lamp out of the circuit.

THE LATE WILLIAM HOOPER.

WILLIAM HOOPER died on the 25th September at Beechwood, Clapham Common, in his sixtieth year. During the last twenty years Mr. Hooper had occupied a position of some prominence in telegraphic science, and although our materials for putting this notice together are scant, we shall endeavour to lay before our readers a brief outline of his professional life.

To the telegraphic profession Mr. Hooper's name is well known as the inventor and manufacturer of an india-rubber insulated wire, and the founder of Hooper's Telegraph Works, Limited. We may however point out that as a pharmaceutical chemist he held a very high position, and contributed, in no small measure, to the improvement in manufacturing medicinal preparations from plants.

As an india-rubber manufacturer he was also well known, and especially as the inventor and manufacturer of water beds, &c., for invalids, which at one time were in use in over 1,000 hospitals and similar institutions.

Although we can scarcely regard him as a remarkable inventive genius, there is no doubt that his life presents to us a very satisfactory illustration of well directed energy.

In order to attain to the position which he gained in three such distinct branches of business, much mental ability must have been required, and the way in which this was directed, is as deserving of our admiration as if it had been turned towards purely scientific results.

Mr. Hooper was born at Dillon Barton, near Exeter, and was apprenticed to a chemist and druggist in that city. He opened a business at 7, Pall Mall East, London, as a pharmaceutical chemist, and a few years later opened a branch at 55, Grosvenor Street, and a laboratory in Scotland Yard. The space employed for this purpose being subsequently taken by the Electric Telegraph Company for a store or depôt, the laboratory was removed to Mitcham in Surrey.

At Mitcham he started with Mr. Fry in the manufacture of india-rubber goods, trading under the name of Hooper and Fry. On the retirement of Mr. Fry from the business it was carried on by Mr. Hooper until 1860-61, when the general business was dis-

continued to make room for carrying out the manufacture of his patent india-rubber wire under an arrangement with Messrs. R. S. Newall & Co., which, unfortunately, was cancelled by litigation between the parties. A few years later a partnership was entered into with Mr. (now Sir George) Elliott, and it was said that this arrangement on the part of Sir George Elliott was to induce the Gutta-Percha Company to combine with the firm of Glass and Elliott to form the present Telegraph Construction and Maintenance Company.

This was followed by a second arbitration, so that the first seven years of Mr. Hooper's patent flew past without the slightest benefit accruing. It is perhaps within the mark if we say that at least £25,000 was spent during these seven years to free Mr. Hooper's hands, and to allow of the working of his patents.

Not only did Mr. Hooper rely on his own individual resources for perfecting his patents and securing a trial of the merits of his core, but he succeeded in removing a very strong feeling of opposition which at one time seemed too influential to admit of being overcome by a private individual.

In the year 1865 several lengths of india-rubber insulated wires by different manufacturers were sent to India to test their durability and suitability for that climate. The only one which remained good was that made by Mr. Hooper. This led to his receiving several orders from the Indian Government, and established the reputation of his manufacture. We believe that about 12,000 miles of cable have been made with this core, the last of which, made and laid for the Cuba Submarine Telegraph Company in 1875, is a practical proof of its merits. Without exception it is, when well made, electrically, the most perfect cable in existence.

In the year 1870 Mr. Hooper's business as a contractor had increased so extensively that he formed a limited liability company, which was known as Hooper's Telegraph Works, Limited.

Little is known of what led to the collapse of this company, but at the time negotiations had been going on for making and laying a cable to the Cape, for which line Hooper's Company held the concession, &c., from the Government. We have heard that the manufacture of an Atlantic cable for the French company was also being negotiated for.

Mr. Hooper was a liberal supporter of science, and we have been informed that no invention bearing on submarine telegraphy which was submitted to him was dismissed without the most attentive study.

One very important matter which Mr. Hooper had worked upon was the protection of iron, &c., used in the covering of cables. In his earlier patents he proposed a covering of vulcanized rubber for this purpose. Attention is being again directed to this matter from the fact that two Atlantic cables are now defunct from the corrosion of the iron wires not allowing their being fished up.

It is a general opinion that Mr. Hooper largely profited by his company; this we believe is an error. If we consider that Mr. Hooper, in the first place, held over one-fourth of the total shares of the company, and that the latter was indebted to him for nearly £150,000. We can easily conceive that he would have been a great deal better off without the questionable extension of business which it is considered accrues from the conversion of a flourishing undertaking into a limited liability concern. Few men have perhaps worked harder for an object where such disappointing results have followed. It is not often that it is our pleasure to refer to a life more usefully spent; we should therefore have regretted to allow the moment to pass without adding our token of respect to the memory of the late William Hooper.

We fully believe that one very important benefit to submarine telegraphy, arose from his labours and those of other india-rubber manufacturers threatening the monopoly of gutta-percha as an insulator, which led to great improvements in gutta-percha cables.

VANDER PLOEG'S TYPE PRINTING TELEGRAPH APPARATUS.

There have perhaps been invented more varieties of type printing than of any other kind of telegraph instruments. Many of these differ from one another in but very unimportant details, and it is not often that any very distinct points of novelty are introduced. Mr. Ploeg's apparatus, however, decidedly possesses features which, as far as we know, are not found in any existing forms of printing instruments, and therefore it well deserves being brought to notice.

The apparatus consists essentially of a transmitter, a "speaker" and "reinforcer," and a receiving and printing apparatus.

The transmitter, fig. 1, is constructed with a handle 1, which in several revolutions imparts by means of a pinion 5, and wheels 3, 4, one revolution to an axis on which the needle 10 is fixed.

The handle has four optional points of rest, 6, 7, 8, 9, placed in horizontal and vertical lines, and in turning it forwards or backwards the needle 10 is turned in the same direction; the points 6, 7, 8, 9, correspond to the spaces on the dial around which the needle 10 turns.

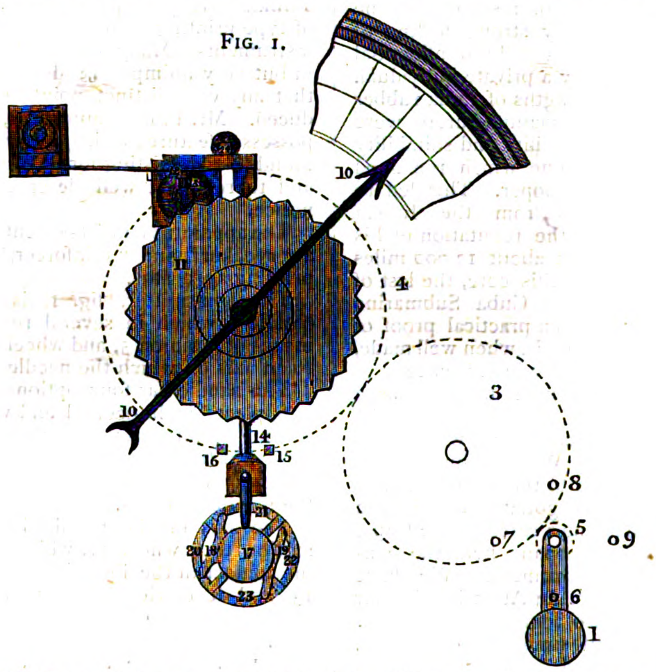
The axis of the needle is attached and gives motion to a wheel 11, which makes or interrupts the contact in the line circuit at the points 12 and 13, and it carries by friction a bar 14, which is pushed against a stop 15 when the axis is turned from right to left, and which is pushed against a stop 16 when the axis is turned in the reverse direction. Whilst moving between 15 and 16, the bar causes an oscillation of a reverser or commutator 17, the two arms 18, 19, of which, separated from each other, sometimes put the part 20 in contact with 21, and 22 with 23, and sometimes 20 with 23, and 21 with 22. Thus the current of the battery, which enters the apparatus at 20, passes through it by the points of contact 12, 13, and leaves it at 21 to pass along the line and return by the earth at 23, will be reversed according to the direction in which the handle 1 is turned; it will be positive in the line on turning the handle from right to left, and negative on turning it from left to right, or *vice versa*, but always inversed in a contrary direction.

To clear the line at the point of departure of a possible overcharge of current, there is a small spring 24 which brings the line into contact with the earth between the reversals of the current.

The dial contains a double border divided into any required number of spaces for the characters required in telegraphy. For those in the outer border the handle is turned to one side, and for those in the inner border it is turned to the other side. At each character there is in the apparatus a contact, and at each passage from one character to another there is an interruption, and an inversion at each change of direction.

The speaker (so-called) and reinforcer is shown by fig. 6. When at rest, one of its arms 26 remains fixed against the point 25, and then allows the current of the batteries A and C to pass through 28 and 27 to the transmitter; the battery B is then not in action. When the finger-stud 31 is pushed down, the arm 26 retires from its point of contact 25; but before leaving it the opposite arm 32 touches its point of contact 33, and at that moment the points 25 and 33, are in communication, so that the poles of the battery B are closed, and the current passing through the sounder 34 attracts its armature, which thus makes a noise or sound. On continuing to push the rod 31 down to the bottom, the arm 26 is made to leave its point of contact 25, and thus there is a communication only between the points 27 and 33, and at this moment the battery B is connected to the batteries A and C, which now regularly enclose all the elements. In this position the line current which passes through the transmitter will be considerably increased; however, there is, between the depressing and releasing of the stud 31, an alternative as to the current of the line, that is to say, either there is a current in the line, or there is none; if there is a current it continues to pass through the sounder 34 (which is wound with thickish wire) and so keeps its armature attracted. On lifting the hand from the stud, the lever resumes its former position, and the armature of the sounder falls back; in this case only one sound is heard; if, on the contrary, there is no current in the line, the armature falls back immediately the connection of the three points of contact 27, 25, 33, is broken, which is done twice, *id est,* once when the stud 31 is pushed down to the bottom, and once when it is released and resumes its former position; in this case the sound or noise of the attraction of the armature is necessarily heard twice. From these movements it follows that the operator will be enabled to be sure at each pressure of the stud whether the current has passed through the line or not, for in case he hears the speaker sound twice when pushing down the stud, in spite of the contact at the point 28 in the manipulator, he is warned that the current is stopped, either by accident or by the actions of the telegraphist at the end of the line, and he stops telegraphing and puts his apparatus in readiness to receive.

FIG. 1.



With reference to the functions of the reinforcer, it will be seen that it serves to print the character to be transmitted at the receiving office.

The receiving apparatus is shown in end and side elevation by figs. 2 and 3, and in plan by fig. 4.

The line current passes direct through the electro-magnet 37. At each side of, and near the poles of the latter, are placed vertical electro-magnets 40, 41, with oscillating cores and pole pieces 38, 39; to these pole pieces are attached arms 42 and 43.

At the extremities of the arms are placed pins 44, 45, the pressure of which respectively against the rods 46 or 47, when its arm is in action, makes a contact at the points 48 or 49.

The poles of 38 and 39 are inverse to one another, the effect of which is that the large electro-magnet 37, when it is traversed by a current of ordinary intensity in one direction, moves one of the arms, whilst the other remains stationary, and if the

FIG. 2.

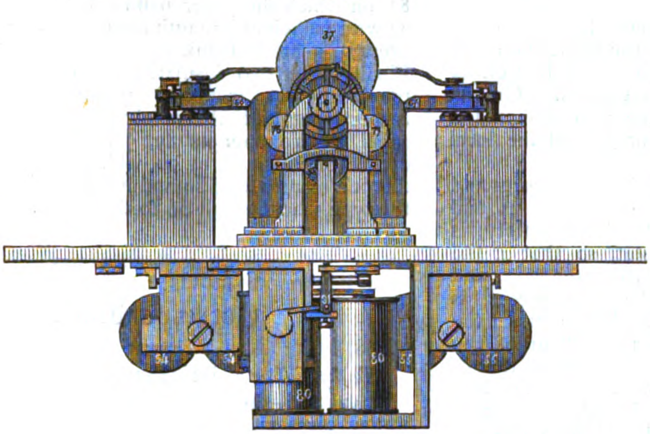


Fig. 6

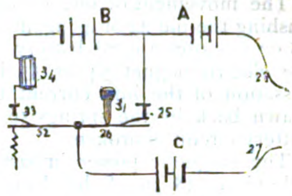


FIG. 5.

FIG. 3.

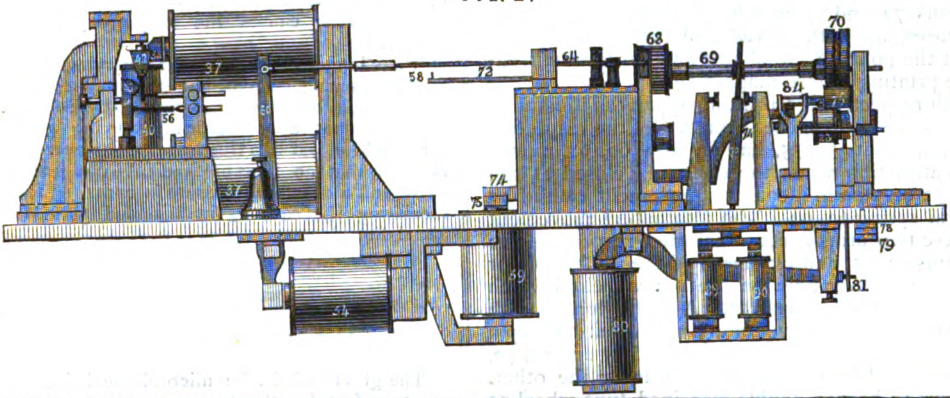
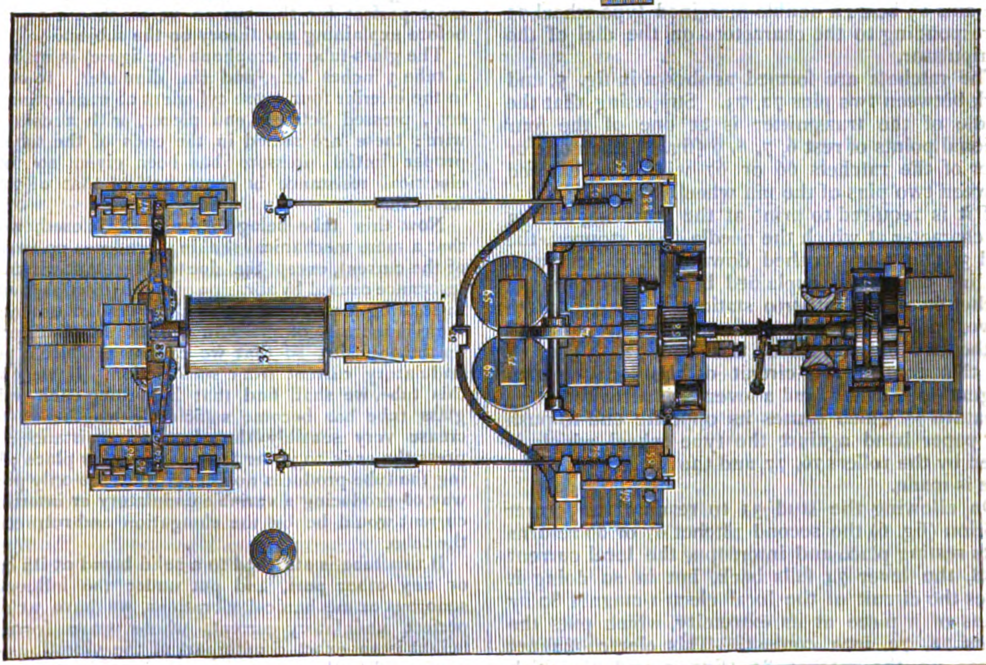


FIG. 4.



current is reversed the other arm is caused to move.

The movement of one or other of the arms by pushing the pin 44 or 45 against the point of contact 48 or 49 closes a local battery circuit, so that either the electro-magnet 54 or 55 is excited. On the cessation of the line current, the arm attracted is drawn back by the springs 56 or 57, and the local battery circuit is broken.

The magnetic power imparted to the cores and pole pieces 38, 39, of the electro-magnet 40, 41, and which is obtained by means of a local battery, is regulated by means of a rheostat, so that if the current which traverses the electro-magnet 37, and which has attracted one of the pole pieces, is greatly increased in strength, it will also attract the other pole piece, because the magnetism of the latter, although it is of the same polarity as that of the pole of 37 opposite it, is very much weaker than the magnetism of the latter. By this attraction both arms 42 and 43 are moved, and both electro-magnets 54 and 55 are called into action, so that the arms 72 and 73, which are connected to their armatures, are both moved, and thus make a contact at the point 58, circulating another local current in the printing electro-magnet 59.

With respect to the printing apparatus illustrated by the same figures, each armature of the respective electro-magnets 54, 55, has an arm 60, 61, moved by its attraction when the circuit is closed at the point 52 or 53, and a counter movement caused by a spiral spring 62, 63. The alternating movement of these two arms is communicated respectively to the arms 64, 65, and by means of the ratchets 66 or 67 working alternately on the pin wheel 68 which runs backwards or forwards. A slight stop beneath the wheel prevents involuntary vibration. The pin wheel turns the axis 69 which is held by an arm 70, and is pushed by it towards one side or the other. The axis 69 bears a double-margined type wheel 71 corresponding to the characters on the dial of the manipulator.

The ratchets are formed as shown in fig. 5, and work between two pins 72, 73. Supposing that the handle of the transmitter is at one of the four optional points of rest 6, 7, 8, 9 (fig. 1), then one or other of the ratchets 66 or 67 will have entered between two pins of the pin wheel.

If it is required to print at the receiving station the character at which the needle 10 is stopped, the stud 31 (fig. 6) is pushed down, and so increases the line current as explained before. The second ratchet 67 or 66, hitherto stationary, then tries to move, but is stopped by the contact at the point 58 of the two extremities of the arms 72, 73 (fig. 4). By this contact the circuit of the local electro-magnet 59 is closed, and a lever 74 is attracted at its armature 75 which causes its opposite end to push the paper band against the type wheel, which is inked by the rollers 76, 77, and the impression of the type is made.

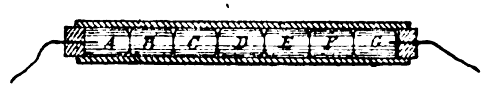
On allowing the stud 31 to resume its former position (fig. 6) the second ratchet 67 or 66 returns to its resting place and interrupts the local current at 58, the lever 74 falls back, but in so doing it closes the circuit of the local electro-magnet 80 by means of a piece at its extremity, which puts the points 78, 79, into contact. This electro-magnet pushes up the ratchet 81 (figs. 2 and 3) which working in a small pin wheel 82 moves the rollers 83, on which the paper band is held by two springs 84 with sufficient strength to make the band pass and present a fresh blank space to the type wheel. Finally, the two insulated arms 64, 65 (fig. 4), touching the insulated points 85, 86, close respectively and alternately local circuits of the small electro-magnets 89, 90, thereby causing an oscillation of the arm 70, which causes sometimes the one margin, and sometimes the other margin of the type wheel to fall on to the paper.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—In your last number, Mr. Frederick Varley gives an account of a very interesting experiment throwing light on the action in one particular of the microphone, but at the same time he fails to explain what causes the varying pressure at the contacts.

It has long been known that a varying pressure produces a varying current, and the action of the microphone would be easy to explain if by a diaphragm or its equivalent a mechanically varying pressure was arranged for, but in a true microphone every precaution is taken that no such mechanical arrangement should exist, and a constant pressure is arranged for, even by insulating the carbons in a sealed glass tube from aërial disturbances.



The glass sealed tube microphone being one of the most perfect for the human voice, should be studied before explaining any theory on the subject.

The glass tube microphone (see figure) is made from a tube 3 inches long, and ¼in. diameter. It contains in the interior four loose cylinders of conducting charcoal, pressed between end pieces, with a conducting wire: these are sealed in the ends of the tube after proper initial pressure has been given, so that its electrical resistance is about half of that of the exterior line.

Now this tube being hermetically closed, we find that a mere mechanical shaking produces no variation of the current, except that due to a constantly increasing resistance caused by abrasion of the carbon contacts. If in shaking it we force one of the cylinders on one side, there is increase of pressure on that side but decrease on the opposite, so that we cannot produce a perfect undulatory current from such action. If we observe this tube, we shall find that by pulling each end, the glass tube has become sufficiently lengthened to increase very sensibly the electrical resistance; if we press the ends together the reverse takes place; bending the tube produces no change, thus the only possible way of producing a variable undulatory or intermittent current would be by the elongation and retraction of the tube.

If this tube is attached to a solid board at its centre, or any other part, and put under the influence of sonorous or mechanical vibrations, we have at once a perfect undulatory current, whose wave form and height is an exact counterpart of the vibrations communicated to the tube.

Knowing as we do that this varying current can only be produced by a varying length of the glass tube, it becomes necessary to examine this point; evidently the tube does change its dimensions under the influence of sonorous vibrations, and we cannot suppose that the tube has lengthened without admitting that each molecule that it contains has undergone its proportionate change of form. If it was not so the tube in lengthening would be broken if there was no elasticity and consequent freedom of action of the molecules of the glass tube.

I shall be very happy to listen to any other explanation than the one I have already given, but it must be one that explains all the phenomena of the microphone as perfectly as the molecular theory I have advanced.

Sincerely yours,
D. E. HUGHES.

H. A. W. FANSHAWE.—We are obliged to you for having pointed out the existence of an error in the formula in question, so that we have been enabled to correct it. The substitution of a symbol for the expression you mention would no doubt have enabled the equation to have been inserted in column width, but would not have enabled it to be solved numerically with greater ease.

With further reference to the algebraical problem, we must point out that if the equation $A = \frac{a}{a+b} F$ be true, then A is quite independent of c and d; or, in other words, if we suppose c to be constant, then if d be increased or diminished, no alteration will be produced in A, which is clearly not the case.

Your arrangement for working Sieurs' double transmission system would not work in practice for two reasons: first, the lever would not oscillate between the two stops but would simply quiver on the stop l_1; and, secondly, the pole of the battery connected to l_1 would be permanently to earth through the sounder coils and local battery.—EDIT. TEL. JOUR.

Review.

Elettricità e Magnetismo. By RINALDO FERRINI, Professor of the Regio Istituto Tecnico Superiore of Milan. Illsico Hœpli, Milan.

THIS work, to a great extent both in name as well as in contents, may be considered as an Italian edition of the work of Professor Clerk Maxwell; but at the same time the extent of ground covered is greater than is the case in the treatise of Professor Maxwell, as under the head "Electricity and Magnetism," the Electric Telegraph, Electro-metallurgy, the Application of Electricity for Blasting Purposes, Electric Lighting, the Telephone, &c., are included.

Although it is of course impossible, even in a volume of 600 octavo pages, to thoroughly consider all the subjects treated of, yet the amount of information given in M. Ferrini's work is very great, the matter being judiciously chosen and well put together; moreover the information is well up to date; the quadruplex is, however, not described.

From the nature of the work frequent extracts from foreign publications have been inevitable, but in all cases Mr. Ferrini has acknowledged his indebtedness. We observe that extracts from the *Telegraphic Journal* occur in several places throughout the work.

Illustrations, considering the size of the work, are not numerous, but are inserted wherever necessary.

Altogether the work is a highly creditable production, and is one of which Italian electricians and physicists may be proud.

Notes.

THE TELEPHONE.—It is rumoured from Paris that an improvement of great importance has been made on the Bell telephone by Messrs. Gower and Roosevelt. By it it is possible to hear a telephone speak when held several feet from the ear.

M. DUMONT gives the following description of a new telephone transmitter presented by him to the French Academy: A parchment membrane, 12 centimetres in diameter, is stretched upon a vertical hoop. To the centre is fixed a wire retained from one side by a knot, and which, first running horizontally from the other side, envelopes a pulley and supports at its lower extremity a small cone of brass suspended by a hook fixed at the centre of its base. This piece relatively heavy enough (20 grammes), plunges its point to a depth of about 1 millimetre into a metal cup filled with carbon dust. This cup is fixed upon the wooden base of the apparatus which supports the membrane. One of the poles of a battery of four Leclanché elements is in communication with the metal cone, the other pole communicates with the metal cup containing the powdered graphite or carbon. The smallest vibrations impressed upon the membrane by sonorous waves suffice to modify, through the intervention of the pulley, the pressure of the cone on the carbon dust, and so determine telephonic variations of current which can be received in a Bell telephone.

IT has been proposed by M. de Parville to apply the well-known fact that a long bar of soft iron held in the magnetic meridian can be employed instead of the magnet in a telephone, to the determination of the magnetic meridian. The telephone so constructed gives its loudest effect when the bar, which should be a metre long, is in line with the magnetic meridian, and when it is at right angles to the meridian the sound is more or less completely silenced. This plan he thinks might be useful on board ship, for compass correction, when the magnetic influence of rocks falsifies the readings. M. de Parville also proposes to utilise the temporary magnetism in a soft iron bar in order to trace out the different courses taken by a ship by an automatic dead reckoning. For this purpose, he would fix a rod several metres long in the axis of the ship, with a coil fixed on one extremity, and the feeble induction currents generated in the latter as the ship changed her direction would be caused to operate a delicate inking arrangement similar to that of the siphon recorder.

THE only grand medals awarded for electric inventions at the Paris Exhibition have both been carried off by Americans. They have been given to Mr. T. A. Edison and Mr. Elisha Gray for the invention of telephones. Mr. Elisha Gray deserves a considerable share in the honour of inventing the first speaking telephone,—more than he obtained to begin with; but if the French award means that he is the true and sole inventor of the speaking telephone to the exclusion of Prof. Bell it gives him more than his due. Gray invented the electro-magnetic receiver, perhaps a

little before Bell, but it was Bell who made the electro-magnetic transmitter, and produced a complete electro-magnetic telephone. In fairness the honour should at least be divided betwixt these gentlemen.

EDISON's carbon telephone has been adopted by the Gold and Stock Telegraph Company, New York, to work on a central office system whereby subscribers can converse with each other by wire.

ACCORDING to *Dingler's Polyt. Jour.*, MM. Serpieri and Cappanera have studied the sounds which are only imperfectly transmitted by the telephone, and find that there is a frequent confusion of the following sounds:—*e, a; tr, cr, dr, pr, fr; n, m; s, f; et, el; eb, eu; d, t; ic, ip; dra, tra, gra; te, chi; at, ai; i, u; l, r; o, e; v, b.*

THE STRING TELEPHONE.—Mr. N. R. Huntley, an engineer of Springfield, Mass., U.S., has so far perfected the toy telephone as to talk plainly across the Connecticut river, a distance of 2,450 feet, or nearly half a mile. The boxes have thin iron diaphragms. The line is not straight but zig-zag, and is supported by iron pins fitted with glass insulators, which prevent the sound from leaking. He fully expects to make a serviceable private telephone out of this arrangement.

Mr. F. G. LLOYD, who simultaneously with Prof. Hughes, has been investigating the production of sound in the telephone and in electro-magnets, thus describes in *Nature* a receiving telephone made by him without a diaphragm:—Two ordinary electro-magnets (unscrewed from a couple of large electric bells) were fastened, by means of two little wooden saddles and a screw each, to a small piece of deal board about 4½ inches square and ⅝ inches thick, in such a way that the poles were all but touching. Their wires were then joined so that poles of opposite denominations faced each other; *i. e.*, north opposite south, and *vice versâ*. This placed on an empty cigar-box and four Leclanché cells in circuit (with a transmitting microphone) gave out the tune of the musical box clearly and loudly in the room. When both poles were made to touch, the sound ceased; but with a thin piece of paper or stout tinfoil between them, without any intervening air space, the sound was heard. On gradually separating the magnets, the sounds grew fainter and fainter, till they became inaudible. By putting the base board close to the ear, whistling, singing, and talking to the microphone, were clearly distinguished.

THE MICROPHONE.—The original microphone of Prof. Hughes has, we believe, been deposited in the museum of the *Conservatoire des Arts et Metiers.* It is a matter for regret that we have no similar high-class depository in this country for such interesting memorials of scientific labours, and that the first model of this important English invention should not have found a place of honour in England. We trust that before long the Society of Telegraph Engineers will be provided with a museum as well as a library worthy of it. The Patent Office Museum, that lumber-room of old firearms and antiquated beam-engines, is out of the question for such a purpose as this.

A PIECE of ordinary black-lead pencil sharpened at both ends acts very well as an upright piece in the pencil microphone. It is very light and sensitive even when fitted into brass sockets.

MR. COLLISON, an electrical mechanic of Glasgow, informs us that he has made a very sensitive microphone of a diamond-shaped slip of aluminium foil for the upright piece and two carbon blocks for the sockets.

MR. THOMAS ROWNEY finds an increase of volume of the sound heard in the telephone of a microphone circuit when the microphone is placed *between* two pairs of elements.

VARIATIONS OF CURRENT STRENGTH BY PRESSURE OF CONTACTS.—It was found by De la Rive that when the circuit of a Faraday or Ducretet electro-magnet is closed between its two poles no spark or sound is observed, but, on the contrary, when the circuit is opened a crack like a pistol-shot is heard. In 1874 it was shown by M. Trève that the same phenomenon, though in a less degree, took place in opening the circuit near a single pole of the electro-magnet, and, further, that the influence of that single pole equally determined the instantaneous stoppage of the little cube of copper originally rotated between the poles. In a recent communication to the French Academy of Sciences, M. Trève points out that this experiment of De la Rive is an excellent means of showing to a large audience the influence of the pressure existing between two contacts on the intensity of the current traversing them. The ends of the wires of the electro-magnet are held in the hands between its poles, and the noise attending the opening of the circuit can be varied considerably by bearing more or less strongly on one thread or the other. This noise, which is hardly perceptible when the two wires touch each other lightly, becomes like the report of a pistol when they are forcibly pressed together. Equally curious effects are to be noticed on making contact with pointed wires.

AN amusing sceptic of the phonograph and the telephone has appeared in the person of M. Bouillard, who, in a paper to the Physical Section of the French Academy, recently gave it as his opinion that Count Du Moncel's exhibition of the phonograph was supported by ventriloquism, and that the telephone is an acoustic illusion. The phonograph, telephone, and microphone have already become so familiar to us that we would be in danger of forgetting how marvellous they seemed to all when first announced, were it not that M. Boullard stands forth as a refreshing reminder of the fact.

THE ELECTRIC LIGHT.—The *Times* office is to be lit by M. Rapieff's electric light. Six lamps have been fitted up in the printing room, and others will be introduced into the compositors' room. It is likely to prove very beneficial to the type setters who work by night in a hot and vitiated atmosphere.

IT is rumoured that a company of leading electricians is about to be formed to introduce the electric light into London.

THE electric light continues to progress in Paris. Fourteen new lamps have been added to the sixteen already existing in the Avenue de l'Opéra. These thirty, together with those in the Place de l'Opéra at one end of the avenue, and those in the Place du Théatre Français at the other end, make fifty-eight lamps in view at once, illuminating one of the most splendid thoroughfares of Paris.

It is said that 400 horse-power are employed in supplying the 180 electric lights now glowing nightly in Paris.

THE Danish Government have decided to light up the ports of Copenhagen and Elsinore, together with

the whole length of the Sound, by electric light. This resolve on the part of the Danish Government is worthy of an enterprising and enlightened people, and as it will be a benefit to Baltic trading ships, we hope to see their example followed by other nations. We trust the time is near at hand when the overcrowded Thames below London Bridge will be nightly illuminated by electricity.

IT is said that the cost of the five Lontin electric lights now illuminating the outside of the Gaiety Theatre and a large part of the Strand, is only 2s. 6d. an hour.

MESSRS. TASKER, SONS AND CO., of the Electric Works, New Station Road, Sheffield, have been publicly exhibiting the electric light at their works there, and have awakened much interest in it amongst the residents of that town.

THE Vestry of Ayr have resolved upon having another and more decisive trial of the electric light in that town.

IN a note of our issue for Sept. 15th, we alluded to a statement in the *World* to the effect that M. Jablochkoff had asked £350,000 from Mr. Hollingshead for his rights to the electric candle system of lighting in England. This statement is difficult to understand when on consulting Jablochkoff's English patent for the electric candle (No. 3552, dated Sept. 11th, 1876), we find the following notice on the title page, "*void by reason of the Patentee having neglected to file a specification in pursuance of the conditions of the letters patent.*" Will some reader kindly explain this?

MR. HOLLINGSHEAD, the introducer of the Lontin light at the Gaiety Theatre, Strand, is now advertising for steam power (from 20 to 200 horse-power) required immediately for this light in the following thoroughfares: Strand, Piccadilly (central), Oxford Street, Holborn, Tottenham Court Road, Euston Road, and Aldgate.

FROM August 8 to October 11, eleven patents for electric lighting were taken out in England, including patents by Siemens, Wilde, and Lane Fox, but apparently none from Mr. Edison till then. It is curious to note as an index of the effect of public excitement on invention that six of these eleven patents were taken out from October 4 to October 11, during the Edison "scare."

AT the half-yearly general meeting of the London Gas Light Company, held on Wednesday, Oct. 2nd, at the Freemason's Tavern, Lincoln's Inn Fields, Mr. John Leng, editor of the *Dundee Advertiser*, urged the gas companies to take up the electric light as an auxiliary to gas lighting. It was generally admitted that the electric light would be one of the lights of the future, and was not to be repudiated or ignored.

AT the half-yearly general meeting of the Phœnix Gaslight and Coke Company, held on Wednesday, October 2nd, at the Bridge House Hotel, London Bridge, Mr. Edward Horner, the chairman, testified to the indubitable beauty and power of the electric light, but gave his opinion that the gas companies had no reason to be "scared" at it, since the question must resolve itself into one of cost. He then gave the following figures as resulting from his recent visit to Paris. At one of the large hotels there they were wont to have 48 gas lights, which at the rate of the Phœnix Gas Company's (3s. 4d. per 1000 feet) amounted to 4s. 10d. a night. Instead of these 48 gaslights, electric lights were now used at a cost of £1 13s. a night. The Avenue de l'Opéra was estimated to cost for gas £885 a year, whereas the estimated cost of the electric light for the same number of hours was £10,625. Shareholders should also bear in mind that of all the business done by gas companies in London that of street lighting was of the least consequence; in their own case he estimated that 1d. per 1,000 feet over the whole concern should cover the whole public lighting of this company. He thought there was nothing to fear from the electric light which was "utterly unmanageable," whereas gas was "perfectly under control." This statement about the value of street lighting to the gas companies is a very important one, as affecting these companies, and appears to mean that the whole proportion of gas used in street lighting amounts only to 1 per cent. of the total supply; and consequently that if all street lighting were done by electricity it would only reduce the gross revenue by about 1 per cent. The chairman also said, as regards the gas companies taking up the electric light, that he feared that it would be found that they had no Parliamentary powers to do so.

THE ordinary half-yearly general meeting of the South Metropolitan Gas Light and Coke Company was held on Oct. 7th, at the Terminus Hotel, London Bridge Station. The rivalry of the electric light was regarded in a hopeful spirit by the manager, Mr. Mivesay, who said that he should like to see certain prominent points of London, such as the Mansion House and the corner of Queen Victoria Street lit by it; but thought that it was not at all suited for public streets, a diffused light being required for such a purpose, and that the electric light could not be diffused. One insuperable objection to the light was, in his opinion, its intensity: and therefore its unsuitability for ordinary lighting. He confessed he had been disappointed with the intensity of the light at the Gaiety Theatre. One shareholder said that the electric light had been successfully applied in Paris; and another gave it as his belief that if ever the electric light should come into vogue there would be plenty of work for the oculists. A dividend of 11½ per cent. was recommended, and the report stated that the price of gas had been reduced to 3s. per 1000 feet.

COST OF THE LIGHT.—In a letter to the *Times* of October 4th, Mr. John Blount, M.I.C.E. stated that he had learned from the Societé General, which conducts the lighting of the Avenue de l'Opéra, Paris, that the cost of each electric lamp (Jablochkoff's system) per hour is 6·25d. not including interest on capital or repairs. The price paid by the Paris Municipality is 13·8d. per lamp per hour. The nominal value of each electric candle is put at 100 gas burners, consuming 140 litres or 5 cubic feet of gas per hour; but Mr. Blount thinks the practical value much lower than this. To compare the cost of the two kinds of light better, he takes Sloane Street as an example. (See also Mr. Stayton's Report in the TELEGRAPHIC JOURNAL for Sept. 1st.) It takes 2s. 1½d. per hour to light with gas the 42 gas lamps in Sloane Street. If 8 electric lights were substituted for these, the cost would be 4s. 2d. per hour, or adding interest on capital and maintenance to this about 5s. per hour. At the price paid in Paris for gas (about 7s. 6d. per 1000 cubic feet) the cost would be 9s. 2d. per hour. It is needless to say that the electric light would be much superior to gas light.

IN the *Times* for Saturday, Oct. 5th, Mr. John Hollingshead timely points out that estimates of the cost of the electric light made on the basis of Jablochkoff's system, the "most expensive light in Europe," do not fairly represent the question. With Lontin's light he is prepared to illuminate large halls

and areas at half the cost of gas, while giving 12 times the amount of light.

An electric gas-lighting apparatus, the invention of M. Hausmann, has recently been patented in Germany. The gas cock is opened and closed by an electro-magnetic arrangement, but the lighting is done by a small gas jet kept constantly burning over the gas burner, and at right angles to it.

Another electric lamp-lighting system is being tried in Pall-Mall.

A pneumo-electric gas lamp-lighting apparatus is being tried at Baltimore, U.S. In addition to the gas pipes, another pipe, containing the conductor and the compressed air, is required. The air is compressed at a central office and being forced through the pipes closes the battery circuit in the different lamps, turning on the gas and generating a spark sufficient to ignite it. The cost of the apparatus, including the pipe and labour of installation, is put down at 40 dollars each lamp.

Telegraphic fire alarms, under Symington's patent, are being rapidly introduced into the streets of Glasgow. In a short time the system will be complete over the whole city. Perhaps the metropolis will then follow the Glasgow lead.

It is stated that the merchants of New South Wales are endeavouring to obtain a duplicate cable to Europe. One of the routes suggested is from the North West Cape to San Francisco, which would require two millions sterling to lay over. Any company which would take the matter up would be guaranteed an annual subsidy of £75,000 by the New South Wales Government. We also hear that a light cable between Freemantle and Rotnest Island, Western Australia, is a desideratum.

Rule No. 8 of the Green Bay and Minnesota R. R. Company, of which Mr. E. C. Belknap is train despatcher, reads "Students in telegraphy will not be tolerated on the lines of this Company." — *The Operator*, U.S.

At a "cable conference" held in Melbourne in May it was agreed that the subsidy of £32,400 to be granted annually to the Eastern Extension Telegraph Company for twenty years for the duplicate cable to be laid between Singapore and Banjoewangie, should only become payable after a second cable between Singapore and Penang was laid. The Eastern Extension Telegraph Company are also requested to reduce their charge for Governmental messages 50 per cent., and for press messages 75 per cent. on the present rates. Provision is also made for the purchase by the combined colonies of the duplicate cable. The subsidy is to be paid by the different colonies ratably in proportion to their respective populations as shown by the 1876 estimate. Arrangements for constructing a duplicate trans-continental line from Port Darwin to Queensland were also taken into consideration. The new Singapore to Port Darwin cable and the Singapore to Penang cable are to be laid within eight months from the date of the agreement, and to hasten the work the subsidy is to commence from four months after signing the agreement. Should both lines be silent at any time, the subsidy will cease *pro rata* for the period of interruption, unless the cause be war. Press messages must be addressed to licensed newspapers only; they must be in plain English, no cypher or code being employed, so that the press privilege shall not be abused by commercial messages.

Paris Exhibition awards of the second class have been obtained by Messrs. Siemens Bros., The Telegraph Construction und Maintenance Company, and the Smith Vacuum Brake Company.

The Lords of the Admiralty have purchased the new iron screw steamer *Stuart*, which has been built in Scotland for the use of the Indo-European Telegraph Company. The *Stuart* is to be fitted out as a store and troop ship.

Lieut.-Col. Murray, of the Bengal Staff Corps, has been appointed Director of Indian Telegraphs.

Mr. Sievewright, general manager of the Cape telegraphs, has proceeded with Governor Frere to Natal to superintend the protection of the new land lines in Natal and the Transvaal.

At a conference of the officers of the Direct Cable Company, held at Portsmouth, New Hampshire, U.S., on September 5th, it was decided to change the bed of the cable leading from Rye Beach, and lay it further off shore so as to clear the fishing waters.

The yellow fever pestilence in the Southern States of America has been playing sad havoc amongst the telegraph operators, many of whom nobly remained at their posts and thus enabled communication to be kept up with the outer world and help to be rendered or tidings to be sent. The Telegraphers' Aid Association are nursing all sick operators, irrespective of the company they belong to. About 9,000 dollars were subscribed up to September 15th for their relief, and branches of the association established at New Orleans and Memphis, the head-quarters of the fever. The Western Union Telegraph Company have agreed to pay the nurses' bills of any of its operators struck down with the disease. Subscriptions from the general public are also coming in.

The cottonwood telegraph poles along the Southern Pacific Railway, U.S., are reported to have sprouted, and promise to form a line of shade.

The Telegastograph.—A paragraph has been going the rounds of the newspapers of late concerning a new electric invention called the "Telegastograph." It consists of a device for transmitting taste by wire, and enabling a *bon vivant* to enjoy all the rich flavour of a feast without the attendant headache next morning. Thus, nice little dinners can be arranged on the Barmecide principle by ambitious middle-class householders, and without the necessity of calling in the services of the neighbouring greengrocer. We cannot see anything very funny in this much-quoted parody of recent electrical marvels, and it may strike many an underpaid operator and unemployed electrician as a sorry joke to suppose that electricity could satisfy any one's appetite.

Mr. Edison has returned from his vacation, and already announces two more new inventions—the sonorous voltameter, an instrument for measuring the strength of telegraph batteries, and a new ink by which blind people will be enabled to communicate with each other. He says he enjoyed his trip through the Far West, and tells a story of being tracked on one occasion by a scout (carrying him a telegram) over a distance of eighty miles, the scout having nothing to guide him but tobacco-juice. "Sharp fellows these scouts," adds Mr. Edison.—*The Operator, U.S.*

In the sonorous voltameter the noise of the bubbles rising is magnified by a funnel, and by counting the number of ticks made by these bubbles per second, the strength of the current is obtained.

The blind ink makes at first a grayish white mark, but soon swells up into relief on the paper, and can then be traced by the touch of the fingers.

Edison is also reported to suggest the following plan for telling the extent of gold ore in mines. The ore is

generally surrounded by a conducting bed such as clay, and his plan is to test the "earth" between the clay at the bottom of the mine and the upper soil. If the clay bed is extensive, the earth will, according to Mr. Edison, be a good one, and an extensive clay bed means it appears, a great deal of ore.

The Telegraph in Manitoba.—The telegraph along the line of the great Canadian Pacific Railway from Fort William on Lake Superior *via* Selkirk in Manitoba and the Leatherhead Pass to Burrard Inlet, on the British Columbian Coast is being rapidly pushed forward. Over 1,000 miles of it have been already built on the two western sections; the total length of the route being 1,946 miles. Where it runs through woodland, the width of the clearance for the railway is 132 feet. The reports of the chief engineer, descriptions and maps of the country, with other documents relating to the line, can be had or seen at the Canadian Government Office, 31, Queen Victoria Street, London, E.C.

Tommasi's Relay on the French Atlantic Cable.—The delicate relay invented by M. Tommasi, fitted with a small mirror which exhibits the deviations of the magnetised tongue on a screen, after the manner of a Thomson galvanometer, was tried at Brest on the French Atlantic Cable last July. The relay so provided is designed to operate the Hughes' printer through long submarine cables. Owing to a difficulty in getting mirror reading clerks, M. Tommasi states that he caused the single letter N to be indefinitely repeated through the cable from St. Pierre. The results are given as follows:—With a battery of 15 Minotto cells the letter N could be repeated 128 to 130 times a minute with great deflection of the image. With a battery of 10 elements 98 repetitions were obtained; with five elements 88 repetitions. With a battery of 30 ele-elements and 10,000 units added to the resistance of the cable (7,500 units) 108 repetitions a minute were obtained with a deflection of about 5 centimetres on each side of zero. Similar results were obtained with the letter R. These trials took place before the Superintendent of the Anglo-American Telegraph Co. at Brest; condensers being employed at each extremity of the cable.

Terrestrial Magnetism and the Polarisation of Light.—M. Henri Becquerel while experimenting on rotary magnetic polarisation, recently found that if a tube, containing bisulphide of carbon is placed between a polarizer and an analyzer in the plane of the magnetic meridian, there is an angular difference of 6·5′ between the two positions of the plane of polarisation when looking towards the south or towards the north. He attributes this difference to the action of the earth's magnetism.

Ponci's Battery.—This new cell, the invention of an Italian professor, consists of a glass jar and porous pot, the former containing a solution of ferric chloride, in which is immersed a carbon plate, and the latter containing a solution of ferrous chloride in which is immersed an iron plate. Both solutions should be made to a strength of 35 degrees of Baumé's scale. The electro-motive force of an element is about $\frac{9}{10}$ of a Daniell.

Discharge in Gases.—According to the recent researches of Drs. Warren de la Rue and Hugo W. Müller with electrodes of plane or slightly convex surfaces the potentials necessary to produce electric discharges in gases at various distances are not proportional to the distances when these are small (less than 0·025 inch), but tend to become so as the distances are increased. These results agree with those of Sir William Thomson.

New Patents.

3367. "Galvanic batteries." J. C. Fuller, F. H. W. Higgins. Dated August 16.

3428. "Ship Telegraphs." J. S. Gisborne. Dated August 30.

3470. "Improvements in obtaining light by electricity, and in the means or apparatus employed therein." C. W. Harrison. Dated September 2.

3518. "Improved electrical apparatus for igniting illuminating gas." A. R. Molison. Dated September 5.

3528. "Improvements in the manufacture of magnetic clothing, such as belts, lung invigorators, knee caps, &c., &c., applicable to any part of the body." W. Wilson. Dated September 6.

3603. "Flexible electric conductors and tips therefor (for telephones &c.)." G. J. Stanford (communicated by E. F. Phillips). Complete. Dated September 12.

3622. "Submarine electric telegraph cables." W. Smith. Dated September 13.

3642. "A new improved apparatus which in combination with an alarm will light a lamp at any desired time." W. E. Gedge (communicated by G. Devillers). Dated September 16.

3647. "Improvements in and appertaining to transmitters for telephones." H. Hunnings. Dated September 16.

3652. "Improvements in machinery for changing an original direction of motion to any angle desired; applicable to marine engine room telegraphs and other purposes." A. Mechan. Dated September 16.

3656. "Improvements in the manufacture of electrodes for electric lighting, and in the manner of partially protecting the incandescent points from oxidising or destructive action." A. H. P. Stuart-Wortley. Dated September 17.

3676. "An improved construction or arrangement of magnets and armatures for the purpose of producing rotary motion or obtaining motive-power or a magnetic current for any of the various purposes for which such current may be applicable." H. E. Newton (communicated by H. G. Hosmer). Dated September 17.

3707. "Galvanic batteries." C. E. Basevi. Dated September 19.

3713. "Galvanic batteries." J. D. Adams (communicated by A. Niaudet). Dated September 19.

3750. "Electrical signs for advertising purposes." J. S. Blackmer. Complete. Dated September 23.

3837. "Electric light apparatus." A. Longsdon. (Communicated by A. Krupp). Dated September 28.

3744. "Rudder motion indicator and telegraphing on board ships by electricity." E. A. Caminada. Complete. Dated September 21.

3804. "Speaking telephones." J. F. Bailey (communicated by E. Gray). Complete. Dated September 27.

3892. "Telephones." J. H. Johnson (communicated by F. A. Gower and C. Roosevelt). Dated October 3.

3985. "Electric Lighting." H. W. Tyler Knight. Dated October 9.

3988. "Improvements in obtaining light by electricity and in conveying, distributing, measuring, and regulating the electric current for the same, and in the means or apparatus employed therein." S. & G. L. Fox. Dated October 9.

3991. "A new or improved method of adapting the electric light to domestic and other ordinary purposes." J. Clark. Dated October 9.

4006. "Electric lighting apparatus." P. Jensen (communicated by S. Marcus). Dated October 10.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

58. "Electric Telephones."—GEORGE STEPHENSON. Dated January 4, 1878. 2d. This consists in placing the vibrating plate of an electro-magnetic telephone between the two poles of the magnet, each pole being fitted with a soft iron pole piece. *Not proceeded with.*

125. "Telegraph Alarm Apparatus."—W. P. THOMPSON (communicated by Sigismund Mohr, Quebec, Canada). Dated Jan. 10, 1878. 2d. This consists in an arrangement whereby fire or other alarm telegrams are responded to, so that the sender is assured that his message has been correctly received. A switch is arranged so that the current can pass through the bell, or through the contact maker, worked by clockwork in such manner that a series of breaks of contact are formed by the spring contact maker coming against notches in a revolving wheel, the spacing apart of these notches being varied so as to give the required signals. Or the switch can be arranged so as to continue the circuit direct. *Not proceeded with.*

131. "Electrical Cables."—DANIEL GÖLLNER, Batavia, Java. Dated January 10, 1878. 2d. This consists in a means of preventing the destruction of submarine cables by marine insects by covering the core with india-rubber, raw or vulcanised, by winding it in ribbons round the core, and cemented so as to form a tubing. *Not proceeded with.*

162. "Producing and applying magneto-electricity."—W. R. LAKE (communicated by James J. McTighe, Pittsburgh, Penn., U.S.) Dated January 12, 1878. 6d. This invention consists in producing currents of magneto-electricity in coils by the vibratory motion of one or more magnetic poles in the vicinity. These vibratory currents can be utilised to reproduce vibratory motions or for telephonic purposes. One mode of producing the currents is to act upon a thin magnetic pole by a toothed wheel so as to set it in vibration when it generates undulatory currents in the coil beside it. The vibrations of the voice or the force of a steam jet may also be used to vibrate the thin pole, which can be made in the form of a vibrating diaphragm. Economy of power is claimed for this method, as it will not be necessary, for the production of intense currents, to whirl large masses of iron. A speaking telephone, consisting of a tubular magnet bent into a horseshoe form and having the coil between its poles is also described. One end of the tube is an open mouthpiece, the other end is closed by a vibrating iron diaphragm which vibrates before the coil, the latter being fixed to the other pole.

191. "Appliances for utilising and conveying sounds or signals from telephonic or sound-producing instruments."—G. E. PRITCHETT. Dated January 15, 1878. 8d. This consists in means for increasing the audibility of telephonic or phonographic sounds so that several persons may hear them simultaneously. This is done by funnels or caps, single or with branching tubes, fitted to the mouthpieces of the sound emitters, and having other ear pieces applied to the ears of the auditors.

General Science Columns.

GEORGE PARKER BIDDER, the famous "calculating boy" and eminent engineer, died on September 20th. He was born on June 14th, 1806, in Moreton Hampstead, Devon, where his father was a mason, and when but a few years old gave signs of his wonderful faculty for computing. Through this peculiar gift, which Bidder in after life, not very convincingly, attributed to practice and training, he became acquainted with Robert Stephenson, who befriended him. He entered an insurance office for some time, but afterwards changed to the Ordinance Survey, and from that to Civil Engineering, becoming assistant to Robert Stephenson in 1831, with whom he participated largely in railway works both at home and abroad. He was engineer of the Danish State Railway, consulting engineer of the Delhi, Scinde, and Punjaub lines, and in hydraulic engineering he constructed the Victoria Docks. He applied the telegraph to railway purposes on the Blackwall and Yarmouth railways; he was one of the founders of the original Electric Telegraph Company, and remained a director of it until 1870, when the Government took over the system. Bidder was president of the Institution of Civil Engineers during 1860-61.

MR. JOHN PENN, the eminent Greenwich engineer, also died at his residence, the Cedars, Lee, on Sept. 23rd. He was born in 1805, became an F.R.S. in 1859. He was a past president of the Institution of Mechanical Engineers, and a member of the Institute of Civil Engineers.

THE foundation stone of the Forth Bridge has been laid, and the works were begun on Oct. 1. It will comprise two great spans of 1,600 feet each, and will take four years to complete.

IT is stated that an international exhibition of machinery will be held next year in the Palais de l'Industrie, Paris.

A NEW SOUNDING APPARATUS.—This sondograph, as it is called, is the invention of Lieut. Pereira Pinheiro, of the Brazilian navy. It is designed to give a continuous delineation of the bottom of the sea along the line on which it is operated. It is only suitable for sounding undulating bottoms, such as the shifting sandbanks and shoals off the mouths of the Brazilian rivers, and is not designed for rocky or broken ground. It is composed of an indicator which takes cognisance of the contour of the bottom, and a register furnishes a graphical trace of it. The indicator is formed of a wooden stem, fitted at its lower extremity by a hollow roller, which rolls upon the bottom, and retains specimens of it for examination. This stem is articulated at its upper extremity around a horizontal axis, which carries a graduated arc intended to show the different inclinations that it takes for the given levels of the bottom, which depend on the versines of these angles. On the same axis is a toothed wheel, which by a pinion and eccentric communicates a rectilinear movement to a style, which traces over a band of paper put in movement by a chronometric motor, a continuous curve, which gives in this way the graphical relation of the changing levels and the speed of the ship. As the direction and speed of the ship can readily be determined, a section showing the soundings along the ship's route can be plotted. M. Pinheiro's sondograph may become useful in hydrographical work at the mouths of rivers subject to sandbars and shifting channels.

THE DIURNAL OSCILLATION OF THE BAROMETER.—M. Renou has recently communicated to the French Academy, the following results of his study of this subject. The sun warms the atmosphere which recedes all around and produces a rarifaction over a great circle. This effect is arrested a short time after, the maximum daily temperature has been attained, that is, towards four o'clock in the afternoon, and produces a maximum of pressure over all the countries situated, on the one hand, six hours to the west, and on the other hand six hours to the east, or in other words, the countries which reckon ten o'clock in the morning and ten in the evening as local time. The atmospheric wave which

produces this effect follows the apparent motion of the sun and shifts its position with a velocity which at the equator reaches 464 metres per second. This wave by its rapidity and the direction of its movement should produce a higher maximum in the morning than in the evening; it should also give a predominance to the morning or the evening maximum according as the winds blow from the west or the east. The minimum of the night is only a relative minimum comprised between the two maxima of the evening and morning. The barometric pressure at 4 a.m. ought to differ little from the mean of the 24 hours. In reality it is some hundredths of millimetres lower, because of the loss of weight due to dew and other causes. The diurnal movement of the atmosphere necessarily produces a diurnal variation in the direction of the winds, a variation, however, which is difficult to recognize. Easterly winds favoured by the morning wave rise early and end almost at sunset. Westerly winds opposed by the morning wave are often allayed then and swell up again in the evening.

ASTRONOMICAL ART.—We recently drew attention to Winkler's remarkable lunar landscape, now being exhibited in London. Something even more extensive, if not, perhaps, quite so artistic, is to be attempted by an American artist, if he can procure a sufficient number of subscribers. Mr. Henry Harrison, of Jersey city, has already painted a picture of the moon, three and a half days old, and although we have not seen it ourselves, it is so highly spoken of by Dr. H. Draper and Mr. Rutherford, that we do not hesitate calling our readers' attention to the artist's proposed publication. The picture represents the moon with the terminator at Mount Glacier, showing the earth shine on the surface in shadow, in which some of the most prominent features, *i.e.*, the craters Copernicus and Tycho, the Appenine Mountains, and nearly all the "meres" are visible. Having submitted the work, Mr. Harrison tells us, to gentleman of scientific repute, and being encouraged by their favourable criticisms, he has concluded, if a sufficient number of subscriptions can be obtained, to publish a work under the title of "Telescopic Pictures of the Moon" in oil colour chromos (the only medium for fac-simile reproduction of painting) two feet in size, with an image of eighteen inchesi n diameter, in six progressive pictures of the following phases:—

1. Three days' old crescent, terminator at Mount Clacier.
2. Five days' old, terminator at the Crater Katharina.
3. Seven days' old, or first quarter.
4. Nine days' old, sunrise at the Crater of Copernicus.
5. Full moon; and
6. Last quarter. An outline drawing, with letter press description, bearing the names and sizes of all objects, will accompany the work, which will be completed in about a year from the time the first phase has been issued, and will be furnished to subscribers complete for 30 dols., or 5 dols. each plate. The description will appear gratuitously with the last issue. Subscribers should send full name and address to Henry Harrison, P. O. Box 179, Jersey City, New Jersey.—*Nature.*

THE AMERICAN WEATHER SIGNAL SERVICE.—This useful system of weather reporting was established by the late Prof. Henry, and is perhaps the most complete and successful one existing. It is conducted under the superintendence of Gen. Myer, better known as "Old Prob," from the daily bulletins of weather probabilities he has been instrumental in issuing for a number of years. The duty of the Signal Service is to protect the commerce and agriculture of America by weather warnings, and give information as to the state of the rivers, lakes, and atmosphere of the various parts of the Union, Canada, and abroad. Code telegraphy is employed to transmit the data to central offices, and disseminate the results throughout the country. The members of the service are specially instructed at Fort Whipple, in Virginia. Over two hundred officers and men are engaged in the work. At each station observations on the temperature, pressure, and humidity of the atmosphere, the velocity and direction of the wind, the appearance of the clouds, and state of the weather, are taken thrice a day, at hours fixed by mean Washington time, to get simultaneous results. The reports are published daily in the newspapers, and in what are termed "Farmers' Bulletins." It is said that the degree of accuracy attained in the storm warnings is represented by 88 per cent. The New York signal station overlooks the city and bay, so that its signals are visible from all parts of the harbour. By day, a red flag with a black centre, and by night, a red lantern, over this building, presage foul weather.

STEAM FOR HEATING PURPOSES.—It is stated that a company has been organised in New York to supply steam for heating purposes. Three miles of street mains have been laid, and at present upwards of forty large buildings are heated by the system of pipes, which derive their steam from one boiler five feet by sixteen feet in size. The pipes run through fifteen streets, and over 1,000,000 cubic feet of space is warmed by the steam, which is supplied at a pressure of 30 lb. to the square inch. The steam, in addition to heating purposes, can be used for cooking food, washing clothes, and extinguishing fires. In addition the hot water from condensed steam is furnished to the houses through the same pipes. The cost is said to be much less than that of ordinary fuel.—*Journal of the Society of Arts.*

City Notes.

Old Broad Street, October 11, 1878.

THERE has been very little to report respecting telegraph property during the past fortnight. Prices have had a slightly downward tendency. In the market for gas securities intense excitement has, however, prevailed, the latest quotations for some of the leading stocks showing a very heavy fall. The letter from Mr. Edison to his agent in London, stating he had discovered a practicable way of sub-dividing the electric light, helped considerably to bring about a panic in an already alarmed market. Gas Light and Coke "A" ordinary, 168-173, are now 150-160; Continental Union, which were on Sept. 30th quoted 17-19, are now 14-16; London, 173-178, are now 150-160; Phœnix, 35-37, are now 30-33; Commercial, 175-180, are 145-155; Rio de Janeiro, 22-24 to 20-22; Oriental, 6¾-7¼ to 5-5¼. We hear that, should Mr. Edison not have made the above-mentioned discovery, there have been six patents taken out in London since the 4th inst. for systems for effecting with facility the same object. The attention of electricians will probably now be given to producing the current as cheaply as possible, and also to conveying it to greater distances with less loss of current strength.

In a letter to the *Times* of Oct. 12, Dr. C. W. Siemens describes a new regulator patented by him, for regulating automatically the resistance in the circuits of the electric lamps so that a number of branch circuits, each having a lamp, may be fed from the same machine by constant currents. Dr. Siemens also gives it as his opinion that (notwithstanding Mr.

Edison's telegram) the electric light in our generation will be confined to the larger purposes of signalling, or lighting large areas and halls, while gas will keep its own as an illuminator of rooms and passages, and as a cooking agent. Dr. Siemens also recommends the gas companies to take up the electric light. This letter has helped somewhat to counteract the heavy depression in gas shares due to Mr. Edison's telegram.

The Jablochkoff electric candle has been introduced into the handsome wareroom of Messrs. Wells & Co., iron and marble merchants, High Street, Shoreditch. The light is given out by four of Jablochkoff's opal globe lamps, each holding four candles similar to those in Paris. The dynamo-electric machine is one of Gramme's alternating current machines giving 1000 turns per minute, or about 16,000 pulses of current per minute. An ordinary Gramme is employed in connection with this one. Messrs. Wells and Co., undertake to give all information about the light, and to furnish it to parties applying to them.

The accounts of the Brazilian Submarine Telegraph Company show a profit for the year ended 30th June sufficient to enable the directors to recommend a final dividend of 2s. 6d. per share, making with previous distributions 5 per cent. per annum, and carrying £50,000 to the reserve fund, increasing that fund to £170,000. The dividend will be payable on the 26th inst.

The Globe Telegraph and Trust Company announce that the interim dividends for the quarter ending October 18th, 1878, will be 3s. per share on the preference, and 2s. on the ordinary shares, payable on and after the 18th inst.

The coupons of the Submarine Cables Trust, due on the 15th instant, will be paid on and after that date by Messrs. Glyn, Mills, Currie and Co., 67, Lombard Street, E.C.

On Oct. 2nd the Great Northern Telegraph Company notified the repair of their Nagasaki-Shanghai cable completed, and of their Shanghai-Amoy cable on the 5th instant.

Notification was given on the 1st instant by the Cuba Submarine Telegraph Company that their 1870 cable between Cinfuegos and Santiago, which was repaired in April last, had again been broken. There is, however, no interruption to business, communication being maintained by the duplicate cable laid in 1875.

Under date Oct. 10 the Eastern Extension Telegraph Company notified the restoration of telegraphic communication with Australia; the Java Port Darwin cable is, however, still undergoing repairs, and until these are completed the traffic will be somewhat delayed. Telegrams for Australia and New Zealand accepted as usual *via* Eastern.

The following are the late quotations of telegraphs:—Anglo-American, Limited, 59½-60; Ditto, Preferred, 88½-89½; Ditto, Deferred, 32-33; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6⅝-6⅞; Cuba, Limited, 8¾-9¼; Cuba, Limited, 10 per cent. Preference, 15¼-15¾; Direct Spanish, Limited, 2-2½; Direct Spanish, 10 per cent. Preference, 10-10½xd.; Direct United States Cable, Limited, 1877, 12⅜-12⅝; Eastern, Limited, 7⅛-7⅜; Eastern, 6 per cent. Debentures repayable October 1883, 107-110; Eastern 5 per cent. Debentures repayable August, 1887, 99-101; Eastern 6 per cent. Preference, 11¼-11½; Eastern Extension, Australasian and China, Limited, 7⅛-7⅜; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; German Union Telegraph and Trust, 7⅜-8¼; Globe Telegraph and Trust, Limited, 5-5¼; Globe 6 per cent. Preference, 10½-10¾; Great Northern, 7⅞-8⅛; Indo-European, Limited, 20-21xd; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 9½-10; Reuter's Limited, 10-11; Submarine, 216-221; Submarine Scrip, 2-2¼; West India and Panama, Limited, 2-2¼; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited, 2¾-3¼; Ditto, 6 per cent. Debentures "A," 85-90, Ditto, ditto, ditto, "B," 86-89; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds; 114-118; Ditto, 6 per cent. Sterling Bonds, 101-103; Telegraph Construction and Maintenance, Limited, 29½-30½; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅝-2⅞; India Rubber Co., 30-31.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£ b	£	£	£ b	£
Sept, 1878 ...	44,310	10,463	* 2,600	1,048	14,770	38,169	22,151	15,778	... ...	9,660	2,200	... ...	* 3,792
Sept, 1877	43,230	9,357	† 2,466	812	15,940	35,440	22,113	18,445	... ...	10,029	1,625	9,504	3,800
Increase	80	1,106	134	236	... ...	2,729	38	... ...	... ...	... ...	575	... ...	... ...
Decrease	... ..	... ...	... ...	... ...	1,170	... ...	... ...	2,667	... ...	1,369	... ...	... ...	8

* Estimated. b Not published.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).

THE TELEGRAPHIC JOURNAL.

VOL. VI.—No. 138.

THE GAS COMPANIES.

THE depressed state of gas shares in the market still continues, and public interest in the electric light has abated but little since our last issue. Everybody is now waiting until Mr. Edison shall throw off the cloak of mystery and unveil the secret of his electric light.* The rumblings of alarm and cries of dismay which resounded on every side a fortnight ago have only given place to a calm suspense; and many people feel that the fate of the gas companies may be trembling in the scales. Very little sympathy is expressed for these companies, as companies; on the contrary, there are few consumers of gas, both great and small, who have not suffered some grievance at their hands, and who do not hail the advance of the electric light with considerable satisfaction. Bad gas, tyrannous measures, and faulty meters, are all keenly remembered against the giant Monopoly which now seems tottering to his fall. Apart from the management, however, the present is a most serious time for the shareholders of the gas companies. It is calculated that there is no less than £130,000,000 of capital invested in the entire gas manufacture and distribution of the United Kingdom, and that of this vast sum nearly £12,000,000 are sunk in the works of London alone. It is a momentous question, then, that is at stake just now. Will this enormous capital be reduced almost to total extinction, or will it merely suffer a trifling depreciation? If the latter, the "scare" will doubtless prove beneficial and the hurt transient. If the former, the result will be little short of a national misfortune.

At a time like the present the Parliamentary privileges and restrictions of the gas companies are worth recounting. They may lay their pipes in any public street within the area defined by the Act, sell coke, tar, and other refuse, sell and rent out meters, and contract with public bodies for the supply of gas. But they must not charge more than the maximum prices fixed by the Act, they must supply all houses within a certain distance, they must supply public lamps at reduced rates, they must not pay a dividend exceeding 10 per cent. on old and generally 7 per cent. on new capital, and any excess of profit cannot be carried over but must be applied in lowering the price of gas. When new capital is issued now, the shares must be put up to auction and cannot be distributed amongst existing shareholders as formerly. The illuminating power is regulated by the Act as also the mode of testing it. In spite of these limitations to their prosperity the gas companies have grown fat, and perhaps also a little lazy and self-satisfied.

But if they have been inclined to slumber of late their awakening has been a rude one, and it has now become clear to them that, in any case, their lot in future will not be so smooth as it has been. The electric light is a declared rival, and if it does not entirely supersede gas, it will at least enter into a formidable competition with the latter, and gas producers will have to bestir themselves to better the quality of their light so as to make it cope successfully with electricity. It has been given out that if all the street lighting in the metropolis were done by the electric light, the loss of revenue thereby to the gas companies would be but a slight percentage of the gross revenue; but if the electric light invades the streets it will not stop there; it will find its way into some of the shops and warehouses too. There is plenty of hope for the gas companies however, if the much needed distributor for the electric current is not forthcoming. They will still have a wide field of domestic illumination to work upon, and if they are compelled to resign the lighting of large stores and factories to the electric light, they may still contribute to this indirectly, by supplying gas to the gas engines which are likely to be in great demand as motors for driving the dynamo-electric machines. For cooking and heating purposes, gas stoves are coming more and more into favour, and there is also something in the likelihood that the introduction of the electric light will raise the general standard of illumination and call for a brighter gaslight in shops and homes. Oil has not entirely superseded candles, nor has gas entirely superseded oil, but each of these has been restricted in its sphere of application by the successive introduction of the other. Even so it is probable that the introduction of electricity will limit the sphere of gas lighting but will not totally eradicate it.

But in the event of Mr. Edison's solution of the problem of electric lighting being as sweeping as he claims it to be, we are confronted with another set of probabilities. A powerful attempt would be made by the gas companies to buy up the new system of lighting. Already we hear that a deputation of their leading men has been convened to wait upon the Board of Trade as soon as the Board can receive them (which will not be until the middle of November) with a view to obtaining Parliamentary powers to supply the electric light. The present powers of the com-

* We hope to give a clear account of Edison's Electric Light n our next issue.

panies limit them to the production and distribution of gas only, in the manner we have seen, and before they can apply any of their capital to the production of electricity they must obtain such powers as only the Imperial Parliament can grant. Troublesome as this course is, and expensive, for fresh capital would have to be expended to install the new light, while the old expended capital would still be a dead loss, it would be the only one left for the gas companies in such a case. It is a course, nevertheless, which would be bitterly opposed, not only by a large section of the public, jealous of the gas monopoly, and irritated against it, but also by private companies already formed to work the light, and, above all, by city corporations and town councils. There is a growing feeling that the water and light supply of towns should be in the hands of the corporation appointed by the whole body of ratepayers. Several large towns, including Manchester, manage both their water and light supply, and it must now be a matter of regret to London gas companies that they have not sold their rights to the City of London ere this. It is a significant fact that the Metropolitan Board of Works have arranged for the lighting of the Victoria Embankment by Jablochkoff's electric candle. Reliable city corporations could supply the electric light to their own citizens at a much cheaper rate than private gas companies paying a dividend on unproductive capital, and they are not likely to lose so good an opportunity as now offers to acquire the privilege.

RAPIEFF'S ELECTRIC LIGHT.

RAPIEFF'S system of electric lighting, introduced into England by Mr. E. J. Reed, C.B., and under the management of Mr. Applegarth, is deservedly one of the foremost now in vogue. A recent trial at M. Rapieff's works, Middle Street, Smithfield, fully demonstrated its excellent qualities to all who saw it; and it has been introduced into the *Times* publishing office on an extensive scale, there being now some eighteen lights employed at that place to light the printing and composing rooms. One great advantage in the light is that it can be sustained for a whole night, if necessary, without change of carbons or any attendance, and the intensity keeps always the same, however much the carbons are consumed, or "burn low." In Jablochkoff's electric candles, the strength of the current increases as the candle burns down, because it flows up one carbon and down the other through the whole length of the candle; but in Rapieff's lamp, the current passes always through the same length of carbons.

Fig. 1 illustrates the regulator form of Rapieff's lamp. The electric wick consists not of two but of four carbons *a*, *a'*, and *b*, *b'*. These are opposed to each other in pairs as shown; the upper pair *a*, *a'*, is fed by the positive current, the lower *b*, *b'*, is fed by the negative current. As placed in the lamp, these four carbons form the figure X, with this difference, that the lower pair is set in a plane

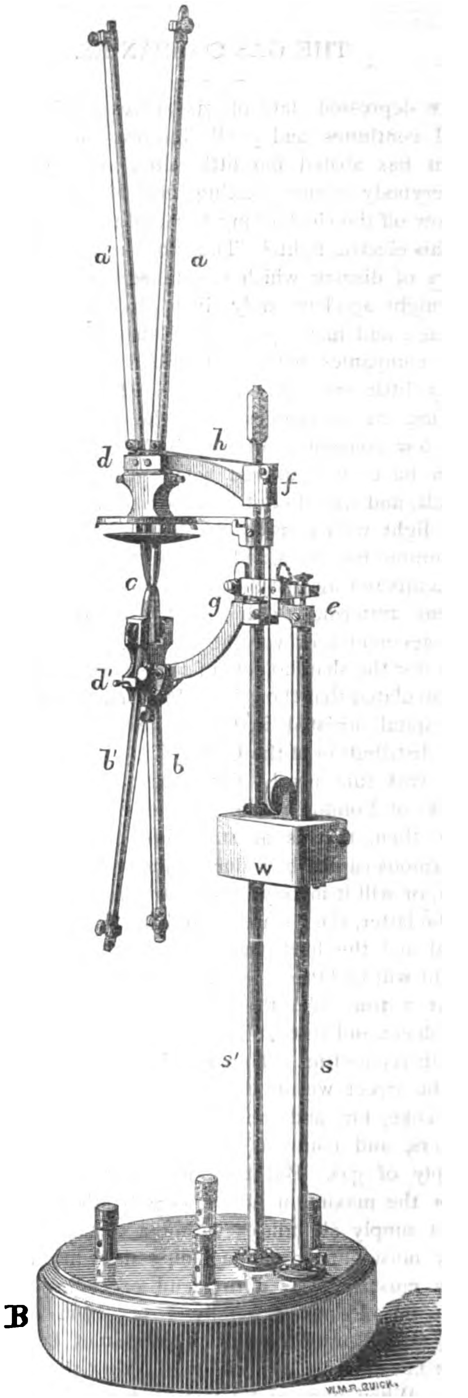


FIG. 1.

perpendicular to the upper pair. Between their points is formed the luminous arc. As the points

consume away, the carbons are made slowly to approach each other, so that the arc is always of the same width, and keeps its fixed position in space. To effect this, the carbons are directed

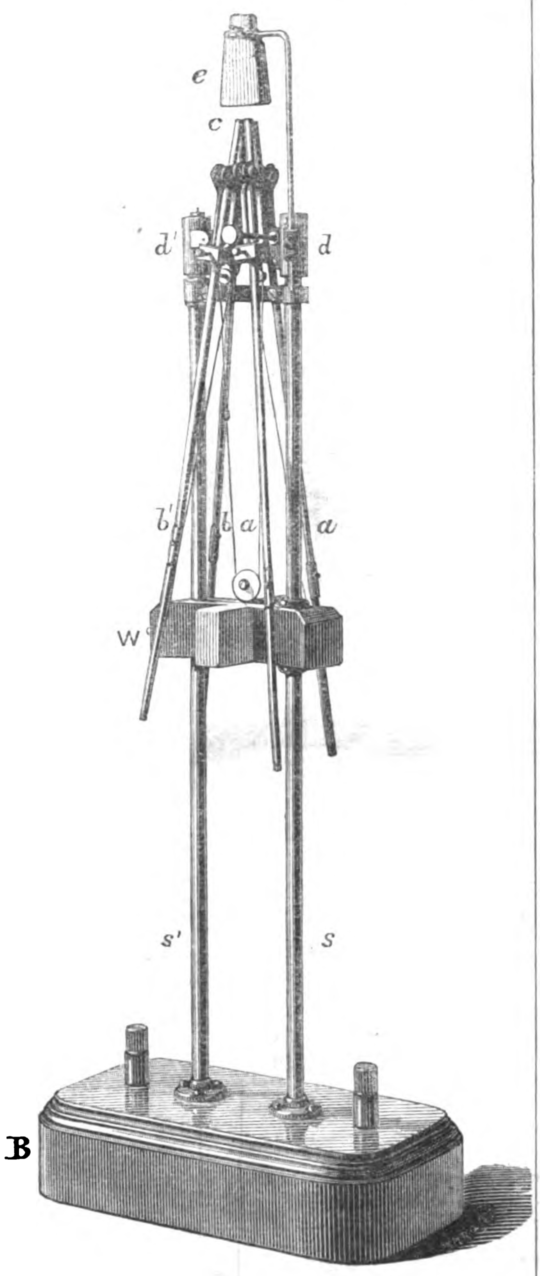


FIG. 2.

together over small pulleys at *d*. The directing force is supplied by a lead weight or counterpoise W, of about three pounds, which slides down the brass stems *s*, *s'*. By means of an iron pulley on the weight W, and other small guiding pulleys fixed at suitable places on the lamp, the weight is supported by two silk or asbestos cords from the outer ends of the carbon sticks as shown. Each cord connects the outer ends of the two opposite carbons, in such a way that the pulley hangs from the light. In this way the descent of the weight draws the four carbons equally together as they are wasted away. A curved reflector of silvered brass or porcelain is fixed a little above the inner ends of the upper carbons. By means of screws at *f* and *e*, the width of the arc is adjusted, and by similar screws the angle at which the lower points face the upper ones can be varied, so as to direct the arc to one side or the other. The lamp is supported by two brass stems *s*, *s'*, from a wooden base B, which carries four terminals for connecting the wires conveying the current. The base is hollow, and contains an electro-magnetic apparatus for starting the light. At first the carbon points are in contact; but when the current is put on, it passes through a dual electro-magnet in the base, the armature of which is attracted upwards, and pushes a rod up the hollow stem *s'*. This rod allows the lower carbons to drop away from the upper to the full width of the arc, as previously adjusted. A detailed description and illustration of this electro-magnet is given in the *Telegraphic Journal* for September 1. The positive and negative currents pass to their respective upper and lower carbons by means of the stems *s*, *s'*, and the curved brackets. With carbons 20 in. long, and 5 millimetres in diameter, the light is maintained for seven or eight hours, and with those 6 millimetres thick it is kept up for nine or ten hours. The light is equivalent to from 100 to 120 gas flames, or say about 1,000 candles. The smallest form of the lamp made gives a light estimated at five gas flames. M. Rapieff is now constructing a form of lamp made to burn upside down, in order that it may be fixed on the ceiling of rooms. Mica plates are sometimes used to screen off the heat from the cords when they are of silk. The resistance of the arc is only two or three ohms.

Fig. 2 represents the moderator form of Rapieff's lamp. In it the carbons are simply inclined to each other at an angle which can be regulated by screws at *d*, *d'*. The width of the arc can also be varied by screws at *d*, *d'*. The carbons are drawn together by the descent of a counterpoise W, in a similar manner to that above described. In this lamp the planes of the carbon pairs are parallel to each other. A cylinder of lime *e* is supported over the arc, and, becoming luminous, increases the illuminating power of the arc by about 40 per cent. The carbons M. Rapieff employs are made by M. Carré. The light is very pure and white, and can be considerably varied in intensity by the adjusting screws. Gramme's dynamo machines are at present used in the *Times* office, but we believe that M. Rapieff has patented one of his own. There are six lamps in each circuit at the *Times* office; but M. Rapieff has successfully exhibited as many as ten.

THE WALLACE-FARMER ELECTRIC LIGHT.

THE Wallace-Farmer system of electric lighting has been brought prominently forward in England within the last few weeks by its connection with the reputed invention of Mr. Edison. The Wallace-

FIG. 1.

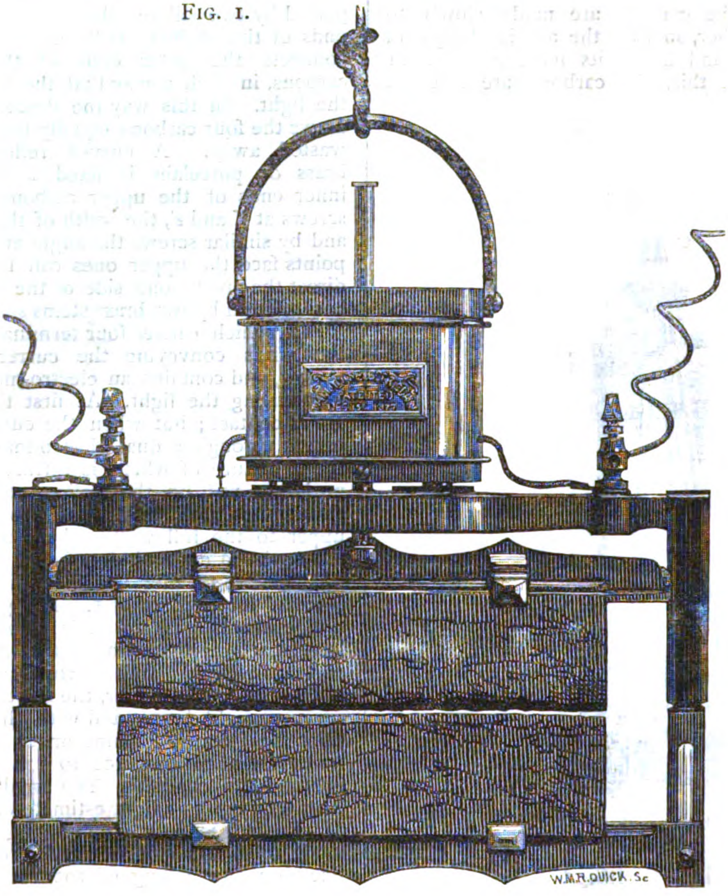
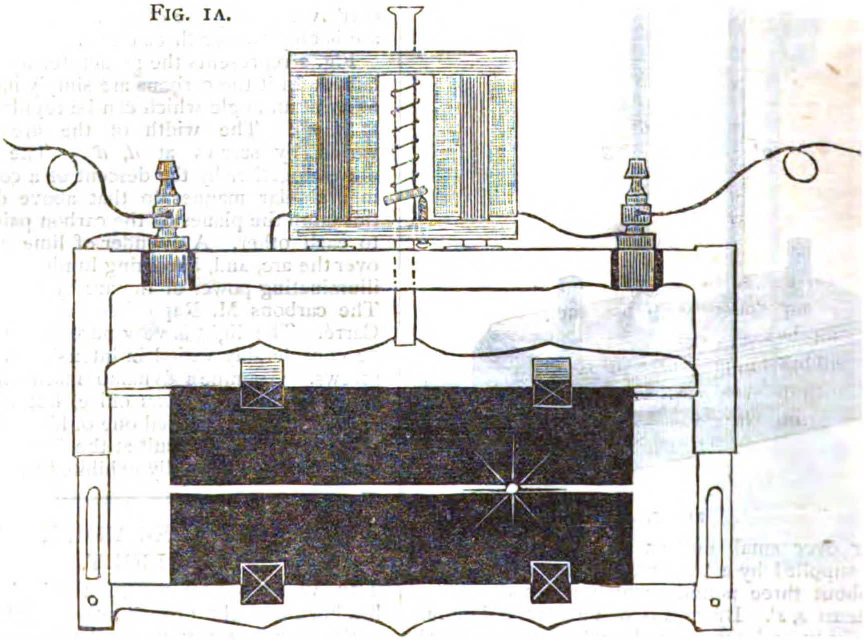


FIG. 1A.



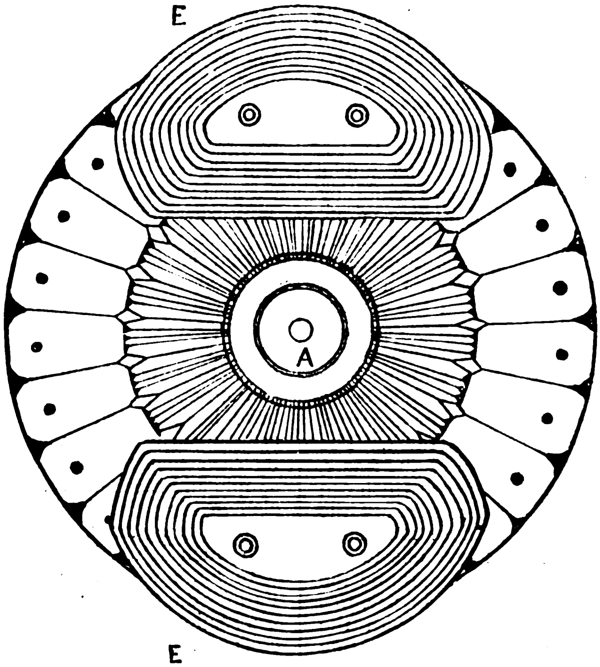


FIG. 3.

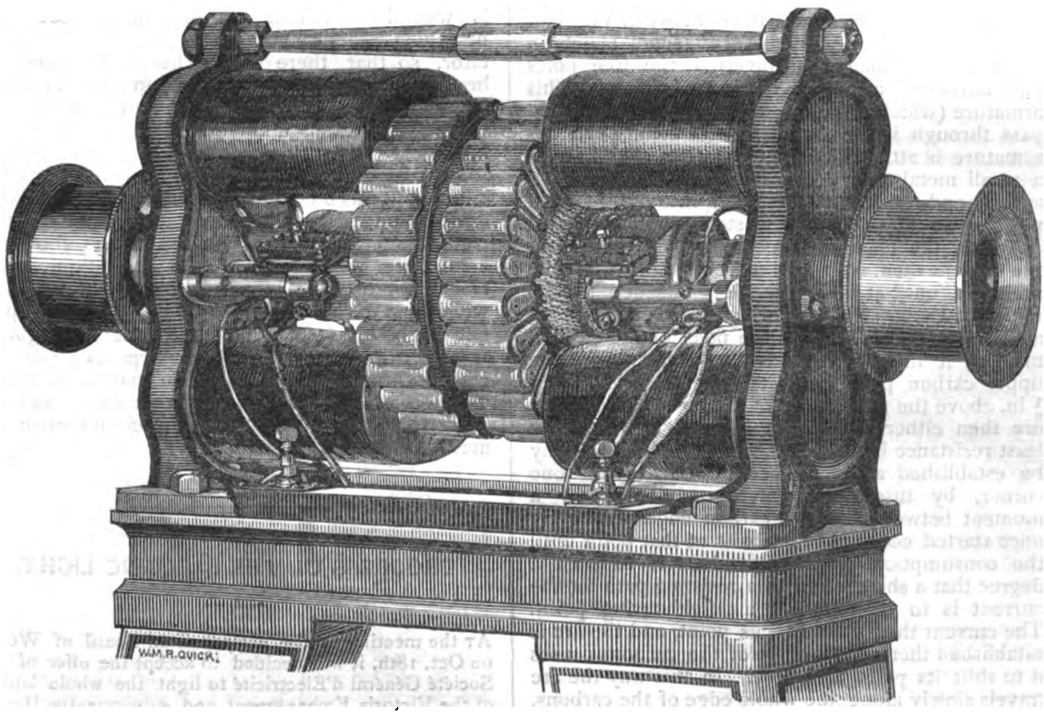


FIG. 2.

Farmer dynamo-electric machine shares American patronage along with the Brush machine, just as the Siemens' machine divides the market here with the Gramme; and it is said to be a Wallace-Farmer machine that Mr. Edison employs in his experiments. The system of lighting in question consists of a special lamp and this machine, for both of which Messrs. Ladd and Co., of Beak Street, are sole British agents. More than one public exhibition of the light has been given in London by these gentlemen at their steam works, Shoreditch, and we believe that it is likely to be widely adopted by reason of its simplicity and cheapness. Figs. 1 and 1A, illustrates the lamp itself. It consists of a metal frame of brass, fitted with terminals for the current as shown. This frame carries the two gas carbons forming the electric wick. These carbons are in the form of short rods or slabs about 9 inches long by 3 inches broad, the upper, or positive, being about half an inch thick, and the lower, or negative, being only about quarter of an inch thick. The lower carbon is fixed to the bottom of the frame, and the upper is carried by a cross-piece, which can slide up or down in grooves in the sides of the frame. The upper carbon is therefore moveable, and can be drawn apart from the lower one to any adjusted distance, say $\frac{1}{8}$ in., so as to determine the luminous arc. When the lamp is not in use, this upper carbon is let down into contact with the lower one, and rests upon it; but the act of putting on the current raises the upper carbon $\frac{1}{8}$ in. and establishes the light. This is effected by means of an ingenious electro-magnetic contrivance, supported above the frame as shown. The vertical stem, which is fixed to the sliding cross-piece carrying the upper carbon, passes between the two bobbins of a double-poled electro-magnet shown in section. This magnet is inverted, the free poles and moveable armature being undermost. This armature (which is perforated to allow the stem to pass through it) carries a screw, which, when the armature is attracted upwards by the current, tilts a small metal ring, or washer, hung from a spiral spring, and enclosing the stem into an inclined position, so that it jams the stem tight and holds it fast in the manner delineated. The first act of the current then, after it is put on, is to attract the armature until it jams the stem attached to the upper carbon, and the armature being further attracted into contact with the poles of the electro-magnet, it lifts the stem with it, and raises the upper carbon plate until its lower edge is about $\frac{1}{8}$ in. above the upper edge of the lower plate. The arc then either establishes itself at the points of least resistance between the two carbons, or it may be established at any place desired, say at one corner, by inserting a metal conductor for a moment between the two carbon edges. The arc once started continues to subsist at that point until the consumption of carbon widens it to such a degree that a shorter and less resisting path for the current is to be found at a neighbouring point. The current then chooses this point, and the arc is established there, until waste of the carbons causes it to shift its place as before. In this way the arc travels slowly along the whole edge of the carbons, and when it reaches the other end, it turns and comes back again. For 100 hours the light can in this way be maintained without change of carbons, and at a cost of about 1d. per hour per lamp for the latter. When the current is cut off, the armature falls away from the poles of the electro-magnet, the screw releases the clamping washer, the vertical stem is freed, and the upper carbon drops down into contact with the lower carbon. When the distance between the carbons becomes at any time too great and the current is enfeebled, the armature will of itself fall away from the poles, and the carbons will close up to each other in this manner. This causes the current to regain its full strength, and the armature being again raised, the upper carbon is again withdrawn from the lower and clamped, and the light thus restored automatically.

It will be understood from our description that the upper carbon cannot be withdrawn in this manner from the lower one to a distance over $\frac{1}{8}$ in., the determined range through which the armature can move. Thus however much the carbons may have been wasted away, at the re-setting of the arc they are always withdrawn $\frac{1}{8}$ in. apart. It will be seen that the mechanism of this lamp is very simple and inexpensive. Messrs. Ladd and Co. are also making this lamp in an improved form, the carbons being narrower and deeper, the frame being also much lighter in construction.

In fig. 2 we give a front view of the Wallace-Farmer duplex dynamo-electric machine, and in fig. 3 a section across the electro-magnets, showing the coils of the armature end-wise, and the connections of the coils to the axle on which the metal collecting brushes rub. E, E, are the fixed inducing electro-magnets of opposite polarity, and *c*, *c*, *c*, are the rotating coils of the armature. There are twenty-five coils set round the armature, and each coil is wound with four separate wires, the ends of which are brought up to the axial commutator, so that there are a hundred makes and breaks, or current interruptions, in one revolution of the armature. The machine can be worked up to 800 revolutions a minute, giving 8,000 current impulses. To drive it the power required is about 1 horse-power for every 100 revolutions per minute. Thus 8 horse-power would be required to drive it at a speed of 800 revolutions, and this rate would feed eight lamps in circuit, the allowance being one lamp for each 100 revolutions. The machine illustrated is made in two distinct parts, which can be worked separately or joined up as one machine. It may be used either for lighting or electrotyping, and other purposes; but for electrotyping is slightly varied in matters of detail. The armature coils, the electro-magnets, and the work to be done, are all in one circuit when the machine works.

PROGRESS OF THE ELECTRIC LIGHT.

AT the meeting of the Metropolitan Board of Works on Oct. 18th, it was decided to accept the offer of the Société Général d'Electricité to light the whole length of the Victoria Embankment, and, subsequently, if considered desirable, the Waterloo Bridge, with Jablochkoff's electric candle. These places are the only thoroughfares in the custody of the Board, and their

enterprise is very commendable. The cost of establishing the light on the embankment is estimated at £600.

A football match by electric light was played at the Bramall-lane Grounds on the night of Oct. 14. Upwards of 30,000 people gathered to see the match, which commenced at 7·30 p.m. The light was thrown on the ground from four lamps, each thirty feet from the ground, and the rays lighted up nearly the whole of the grounds, so that the players could be seen almost as clearly as at noonday. The brilliance of the naked light sometimes dazed the players and caused strange blunders, but the match was highly successful. Behind each goal was placed a portable engine, which drove two dynamo machines, one for each light. The illuminating power was equal, it is said, to 8,000 standard candles, and the cost per hour for each light was 3½d.

The electric light has been introduced into Pullar's Dye Works, Perth, with great advantage over gas, as it shows the most delicate colours in their true tints.

It is also about to be introduced into the *New York Times* composing-room. The present cost of gas there is £100 per month, whereas the electric light is estimated to cost only £20 per month, after the first outlay for installation, which will amount to £200.

The Directors of the Crystal Palace invite offers for lighting the Concert Hall and one other department of the Palace by electricity.

The *Dundee Advertiser* publishes a rumour to the effect that a London mechanic has invented a means of generating electricity by which a house can be lit electrically for a first outlay of £20, and afterwards maintained in light for a few pence per month.

The *Times*, since October 12, has been printed off by help of Rapieff's electric light, no change of carbons being required.

Edison's Electric Light.—We hear that a year ago Mr. Edison discovered a new material which can be rendered luminous by the passage of the current through it, without wasting away. With this material the circuit is perfectly continuous and steady. Edison's system of lighting probably unites this electric wick with a new mode of subdividing the current. Every effort is being made to secure the patents in almost all civilized countries, and as soon as that is done the process will be exhibited in this country. Numerous applications for the sale of the patents or for licenses under them have been already received by Mr. Adams, Edison's London agent. This gentleman has publicly denied the prevalent rumours that "the whole thing is a hoax." A company has already been formed to introduce the light in America; and the English and foreign patents have been applied for.

A continuous wick for the electric light is not a novelty; and Mr. Edison will only be able to secure a patent for it because of the nature of the substance employed. As far back as 1845 an English patent in the name of King was taken out for metal or carbon rods heated to whiteness by the passing current, and in 1873, M. Lodighin revived the plan in the case of carbon, by enclosing it in a vacuum. Three of Lodighin's lights, improved by Messrs. Roun and Bouligine, have been used on the premises of M. Florent, a linen merchant of St. Petersburg, for the last three years. The light is found to be bright and economical; but its special advantage lies in the fact that it has not the deteriorating effect on the white linen which gas has.

Writing to the *Daily News* of Oct. 18, Mr. J. Berger Spence, 31, Lombard-street, claims the honour, of first successfully subdividing the electric light, for Mr. Richard Werderman, who some weeks ago had ten lights from one circuit, and in a few weeks will have some hundreds. A trial of this light, which admits of over ten lights in one circuit, will take place in a few days.

The Otto Gas Engine.—Messrs. Crossley Brothers have orders on hand for Otto gas engines, designed for electric lighting purposes, enough to keep them busy for months to come.

Siemens' Regulator.—The following account of Siemens' new regulator for keeping the resistance in circuit of an electric light constant, is taken from Dr. C. W. Siemens' letter to the *Times* of October 12th:—"In passing an electric circuit from a main conductor into several or any number of branches, the current divides itself between those branches, according to the well-known law of Ohm, in the exact inverse ratio of the electrical resistance presented by each branch. A current may thus be divided, for instance, into ten separate currents of precisely equal force, if each branch is made to consist of a wire of the same length and conductivity; but if one of these wires was again to be slit into ten wires, presenting in the aggregate the same conductivity, each of these wires would only convey 100th part of the total current. In the same way one of the minor wires might again be subdivided into branches each of which would convey an amount of electric current which would be accurately expressed by the relative resistance of the branch in question, divided by the total resistance of all the branches put together. It would thus seem that nothing could be more easy than to divide a powerful electric current among as many branches of varying relative importance as might be desired; but in the case of electric lighting a difficulty arises in consequence of the varying resistance of each electric light or candle, due to the necessarily somewhat varying distance of the carbon points from each other, upon which the length of the luminous arc depends. In order to work a number of lights upon different branches of the same current, it is necessary to furnish each branch with a regulator so contrived that an increase of current corresponding to too near an approach of the carbon points will produce automatically an increased resistance in that branch circuit, whereas an accidental increase in the distance between the carbon points of any lamp will cause the regulator to reduce the extraneous resistance of the circuit to a *minimum*. Such a mode of regulating currents was present in my mind when, in addressing the Iron and Steel Institute in March, 1877, I ventured to express my conviction that natural forces, such as represented by large waterfalls, could be utilized for the production of motive power and electric light, in towns at a distance even of 30 miles from such source, by means of a large electric conductor. This suggestion gave rise to a good deal of discussion and criticism, especially in the United States; but I replied to some of these criticisms in delivering one of the Science Lectures at Glasgow, in March last, having already referred to the matter in a discussion that was held before the Institution of Civil Engineers on the 29th of January last. Having in the meantime perfected the regulator, I showed it in operation at the *soirée* of the Royal Society on the 19th of June, and have only been waiting to get experimental *data* complete, in order to bring the whole subject before one of the scientific bodies. The arrangement may be said to consist simply of a thin strip of copper or silver, say 6 inches long and half an inch broad, stretched horizontally between two supports with a weight or spring exerting a certain pressure in the middle. The branch current to be regulated is passed through this strip of metal, which is thereby heated to a certain moderate extent, depending upon the amount of current passing, and upon the rate of radiation of the heat produced in the strip to surrounding objects. Suppose that when the normal condition of things obtains, the strip of metal is maintained at the temperature of say, 100 deg. Fahrenheit, and suppose that by an accidental approach of the

carbons of a lamp the resistance of the circuit is suddenly decreased, an almost instantaneous increase of temperature of the thin strip will ensue, which will cause it to elongate slightly, and allow the weight resting in the middle to descend, which in its turn causes an increase in the resistance of a small rheostat, through which the branch current in question has to flow.

The Government authorities are trying the adaptability of the electric light for the illumination of large workshops by some experiments at the Royal Arsenal, Woolwich. A new carpenters' shop has recently been erected at the Royal Laboratory Yard, and, pending the provision of gas fittings, a single electric lamp has been hung from the roof, and by its light, men have been making shot-boxes for a week past. It is found that the lamp furnishes a good light to work by for fifty feet in every direction, and that for workshops where the roof is high and the space unobstructed the electric light is suitable and pleasant. The cost of the one lamp has been 8d. per hour, and it answers the same purpose as forty or fifty gas jets, but the steam power for generating the electricity is supplied without charge from the shafting in the main factory adjacent, and nothing is calculated for wear and tear of apparatus. The light, though always brilliant, is somewhat intermittent, consequent upon the ever-varying pressure upon the machinery, which drives more than five hundred lathes, and the small limit between the minimum and maximum number of revolutions required for the electric light is thought to render the employment of standing machinery in most cases unsuitable. The apparatus has been tried in the Shell Factory of the Royal Arsenal, and the light was popular with the workmen, but probably from inexperience, the result was not quite successful. It is proposed to place a light in the outer yard of the laboratory, in front of the model room; and it is also contemplated to light the main factory in the same manner, but the network of machinery and bands and the low pitch of the roof are unfavourable to the experiment.

The Electric Light in Warerooms.—On the evenings of October 9 and 10, Messrs. Wells and Co. gave special exhibitions of the Jablochkoff electric light now fitted up within their commodious and elegant iron and marble warehouse at High Street, Shoreditch. The light was supplied to them by the *Sociétié Géneralé d'Electricité* of Paris, the owners of M. Jablochkoff's patents, and Messrs. Wells will be glad to furnish parties applying to them with information regarding the cost of installing and using the light, and also to undertake the supply of it; but they request an early application as they have now a great many orders on hand for it. The new wareroom of Messrs. Wells, full as it is with handsome particoloured marble and polished metal fireplaces, bronzes, statuettes, and chimney ornaments, is well chosen for a display of the electric light. There are four of Jablochkoff's large opal lamps, 18 inches in diameter, fitted up; the warehouse being some 60 feet long by 35 feet wide, with three galleries and a total height of some 60 or 70 feet. Two of the lamps are supported over the middle of the basement floor, and the other two project on brackets from the upper galleries at the end of the room. The motive power (about 6 horsepower) is supplied by the steam engine on the premises. The light is generated by two Gramme machines of the new alternating current type, revolving at the rate of 1,000 and 1,100 times respectively per minute, and supplying alternating currents at the rate of about 16,000 per minute. By these alternating currents the equal consumption of the parallel carbon rods forming the carbon is ensured. The wicks are of gas carbon with kaolin between. Each lamp is provided with holders for four candles, but only one is used at one time. Each candle burns 1½ hours. When nearly consumed a switch moved by hand, or automatically by an electro-magnet, turns the current to another candle, without disturbing the general effect of the light. The light radiating from the whole surface of the globes is soft and agreeable, while the shadows are scarcely visible. This tempering of the intensity of the light by opal globes, however, cuts off from 30 to 50 per cent. of the total supply. Each lamp is estimated to yield a light equal to 100 gas jets, but it is probably equivalent to many more because of the whiteness of the light as compared to gaslight.

At the meeting of the Commercial Gas Company on October 4th, reports on the electric light in Paris were submitted by the engineer of the Company, Mr. Robert Jones, and by Mr. John T. Sprague, Member of the Society of Telegraphic Engineers. The most noteworthy points in these reports are the following:—According to Mr. R. Jones, the photometric value of a single Jablochkoff or a Lontin light is 600 sperm candles; but, unless a reflector and lens be used, he thinks the power of the light to penetrate space seems to fall off rapidly. The opaline shades reduce their value by 60 per cent. None of the lights were placed at over 200 yards from the machine supplying them. In Mr. Jones' opinion, the electric light might get a field in long, wide streets, and in large halls free from partitions and galleries, where the current expenses of attendance, &c., in a separate establishment would not bear too high a proportion to the amount of light required. But as the main bulk of gas consumers in the metropolis would have but a five-light gas-meter, and use, perhaps, seven lights in a ten-roomed house, fitted as a shop, these people (says Mr. Jones), would have a vested interest in the present mode of lighting, as the gas fittings will have cost them several pounds; moreover, many of their lights are only occasionally used, and others are small lights in passages, closets, &c., where at the very smallest expense, perhaps not 2s. 6d. a year, the place is adequately lighted for their purpose. Any offer of the electric light to such people would, Mr. Jones thinks, be rejected.

Mr. Sprague classifies the electric lights of Paris into two systems, based upon the purpose for which they are used—Lontin's and Jablochkoff's. At the Gare de l'Ouest two of Lontin's lamps are placed over the principal entrance, and five lamps are ranged along the middle of the principal hall, where they replace 34 gas burners. The goods department is lighted by six naked wicks, worked by one machine and steam-engine. The result is very effective, as the men, loading and unloading, can easily see the addresses on the packages, and the work is done readily and safely. In the courtyard of the "Hotel du Louvre," which is roofed in, there are—one lamp in the entrance, two lamps on one side of the courtyard, and six globes distributed over the staircase, forming the other side of the yard. These lights here replace 14 two-light gas lamps and 24 single globes upon the staircase. The shopkeepers do not reduce the gas-lights necessary for illuminating their shops, as some people have expected; and Mr. Sprague estimates that the fluctuations of the light in the Avenue de l'Opéra vary to the extent of one-fourth of the maximum power. In the Hippodrome there are 20 globes on the boundary line of the arena and the audience; between these there are also columns carrying three gas-globes turned towards the seats; above, there are 16 naked lights with reflectors, throwing the light on the middle of the arena. There are thus 36 lights in full action, and in addition there are four naked lights suspended from the roof, and employed during the trapeze performances. "But, with all these powerful lights," says Mr. Sprague, "the result was

poor compared with the rich radiance we are accustomed to in theatres." Mr. Sprague concludes that the electric-light has a place of its own to fill, but that there is little probability of its being adapted to domestic purposes; and he feels no hesitation in expressing the conviction, after full examination of the subject, that the gas companies of London have nothing whatever to fear, and that whatever may happen to gas shares, owing to market operations, gas dividends will not suffer the reduction of a shilling by any competition with the electric light.

The Electric Light in Chancery.—At the Supreme Court of Judicature, on October 15, Mr. Henry Wilde applied for an interim injunction to restrain Messrs. Wells and Co., marble and iron merchants, Shoreditch, from exhibiting Jablochkoff's electric light. Mr. Wilde is the inventor of a dynamo-electric machine, now in use on some of Her Majesty's ships, and possesses patents for it taken out in 1863 and 1865. These patents have been extended to the year 1884. During the past summer, he (the plaintiff), while in Paris, found that the Société Générale were using a machine for lighting several parts of the city with the Jablochkoff candle, which was a plagiarism of his invention. The Société informed him that they intended to introduce the light into England, and Mr. Wilde replied that they must first get his sanction, and negotiations were begun between them for this purpose. In the meantime, however, Messrs. Wells and Co. publicly exhibited the light in question, and although the plaintiff had sent final terms to the Société Générale, who work the light, he had not received any reply. Mr. Justice Hawkins, who presided as Vacation Judge, granted an interim injunction, which was rescinded the following week.

At a recent meeting of the City Commission of Sewers it was decided to light the Holborn Viaduct and the space in front of the Mansion House by electricity.

The Exeter Town Council, who were about to purchase the Gas Works, have refrained at present in consequence of the success of the electric light.

A proposal by Mr. Yeates to light electrically the whole Harbour of Cork for £5,000, by four lamps at a cost of 4d. per hour for each, has caused a panic in Dublin gas shares.

Billingsgate Fish Market will be lit electrically by Jablochkoff's candles on Nov. 5, a Robey's fixed engine being used.

COST OF THE ELECTRIC LIGHT.

The following extract on this somewhat obscure subject is taken from the *Standard* of Oct. 10:—

"Amid all the excitement which prevails on the subject of the electric light, it is remarkable how little is known with regard to the cost of this delightful and effective mode of illumination. Even so scientific a man as Mr. E. J. Reed, writing on this subject to a London newspaper, is compelled to say—'I am unable, although having much to do with the development of M. Rapieff's improvement, to give just at present the exact cost of lighting under his system.' Mr. Reed, however, goes far enough to say that the electric light, as introduced by M. Rapieff, is made cheaper than heretofore, and is 'certainly very much below the cost of gas for equal amounts of light.' Some results are quoted by Mr. Reed from M. Hippolyte Fontaine as having been obtained by the Gramme machine at a cloth factory at Rouen; but the comparison is made with gas at so high a price as to show that London gas would be cheaper than the electric light. It may be as well, therefore, to endeavour to carry the question a step further. Data whereby to judge of the relative cost of gas and the electric light have already appeared in our columns. Thus it is found that the electric light exhibited the other evening over the shop front of the London Stereoscopic Company in Regent-street was obtained from a Siemens' dynamo-electric machine, driven by an Otto silent gas engine, consuming gas at the cost of one penny per horse power per hour. The engine was of eight-horse power, but was only worked up to the power of five horses. The light produced by this rate of working was said to cost, inclusive of all charges, sevenpence per hour, and the amount of light produced was stated to be equal to that of 4,000 sperm candles. On these data it should be stated that a standard gas burner giving the light of 16 sperm candles consumes gas at the rate of five cubic feet per hour. Two hundred and fifty gas burners would be requisite in order to get the light of 4,000 candles, and the consumption of gas for these burners would be 1,250 cubic feet per hour. The lowest price charged for gas in London is 3s. per thousand feet, at which rate the 1,250 feet just mentioned would cost 3s. 9d. But the electric light equivalent to 4,000 candles only costs 7d. At this rate gas is at least six times dearer than the electric light. So far as concerns the quantity of gas used for working the engine, there is every reason to believe that the statement is correct, it having been proved, on good authority, that the Otto engine requires only twenty-one cubic feet of gas per indicated horse-power per hour. Supposing the gas to cost 3s. 6d. per thousand feet, as it probably would do in Regent-street, a penny would purchase nearly twenty-four cubic feet. On the fivepence for the five horse power there is an addition of twopence to pay for carbons and waste, and perhaps something more should be added for interest, wear and tear, &c. But there is a wide margin for anything of this kind. A question may be raised as to the amount of lighting power. From the 4,000 candles we must deduct 30 per cent. for the absorption and loss of light consequent on the intervention of ground glass. This brings down the light to 2,400 candles. If we say 2,000, we then find that the electric light is, at least, three times cheaper than gas, light for light. If there be any dispute as to the actual amount of light emitted by the lamp in Regent-street, it is evident that a very large reduction may be allowed, with a balance still remaining in favour of the electric method.

"It has been said that by a novel application of naphthaline, the lighting power of gas can be enhanced fourfold with a merely nominal addition to the present cost. This of course would disturb the balance of the former calculation; and the gas companies will be wise if they bring this napthaline process to their aid, though it is pretty certain that napthaline will rise above its present extremely low price when it is found to be so powerful an adjunct. As the gas companies are the producers of the napthaline, a rise in its price may perhaps have very little effect on the main problem, seeing that the price of a residual product operates in reducing the cost of manufacturing the gas. It has been already stated in our report, that where the Stereoscopic Company have now one electric lamp they formerly had ten powerful argand burners. These would consume at least fifty cubic feet of gas per hour, the cost of which would slightly exceed twopence. At this rate the gas would cost about one-third the sum debited to the electric light. But the effective light of the latter would be 2000 candles, whereas the argand burners would only give the light of 160 candles. The enormous excess of light furnished by the electric apparatus thus shows itself, and demonstrates the necessity

for sub-division. If the Stereoscopic Company could do what they pleased with the fountain of light thus brought into existence they might illuminate the whole of their premises inside and out, and yet have something to spare. Taking an average of three hours per night for six days in the week, all the year round, the annual cost would be less than 30*l*. To obtain the light of 2000 candles from gas, at 3s. 6d. per thousand feet, would involve a charge of 100*l*. a year. If the reckoning is made on the basis of the entire amount of the electric light, which we have seen is equal to 4000 candles, the cost of an equal amount of lighting power from gas would be 200*l*. per annum."

So powerful a light as that above-mentioned was used by the Stereoscopic Company because they already possessed the machinery for producing a photographic light equal to 4,000 sperm candles, and temporarily employed it for the shop itself. This light is to be replaced, however, by a light equal to 1,200 sperm candles, at a cost of 4d. per hour, and still giving an excess of light. It will take the place of the ten Argand burners, which burned 50 cubic feet of gas per hour collectively. At 3s. 6d. per 1,000 feet, the cost of the gas would be a trifle over 2d. per hour, or half the cost of the single electric light, but the illuminating power of the latter would be about eight times greater. Supposing an opal globe to be used which reduced the light 60 per cent., that is, made it equal to 480 candles, then the electric light would still give three times the light at half the price of gas. With a ground glass globe the light would be only reduced to 840 lights, a still more favourable contrast.

Thus, if the electric light could be produced in moderate quantities, with equal economy as on the larger scale, it would be from 37 to 64 per cent. cheaper than gas at 3s. 6d. per 1,000 cubic feet, according as opal or ground glass shades were used. Without globes the electric light would be 75 per cent. cheaper than gas. With the 4,000 candle light of the Stereoscopic Company these ratios were respectively, 79 per cent. for naked lights, 71 for ground globes, and 50 for opal globes, hence we may infer that lesser electric lights are less economical than greater ones. On the larger scale we have 571 candles per hour for a penny, and, on the smaller, 300 candles for that sum. Sixteen-candle gas, at 3s. 6d. per 1,000 feet, yields the light of only 76 candles per hour for a penny. Even on the smaller scale, then, the electric light would be four times cheaper than gas, were it not for the loss of power due to the globes. Some of the percentage loss due to globes would also require to be deducted from the power of gas flames (for globes are much in vogue with gas) before a strictly just comparison can be made.

M. Hippolyte Fontaine, by taking the cost of gas at 0·25 franc per cubic metre (about 5s. 6d. per 1,000 feet) and calculating from data supplied by the Ducommun workshops at Mulhouse, shows that the electric light from a Gramme machine, quantity for quantity, costs less than gas in the ratio of 1 to 1·26 with interest and deterioration, or of 1 to 7·17 without such charges. For a spinning mill of 800 looms, at the same rate, the electric light would cost 33 per cent. less than gas, give six times the light, and abolish all danger of fire, which is an important consideration in cotton mills. In another calculation, M. Fontaine shows that the electric light from the Gramme machine costs six-and-a-half less than gas at 0·15 franc per cubic metre (about 3s. 4d. per 1,000 feet) for the same amount of light. Under favourable circumstances, where a special motor is not required, the Gramme electric light is estimated by M. Fontaine to be as much as twenty times cheaper than gas at 0·15 franc per cubic metre.

Mr. Sprague, in his recent report to the Commercial Gas Company, gives the following facts and figures as to the cost of the Jablochkoff and Lontin system of Paris. At the "Magasins du Louvre," 201 gasburners costing 90·4 francs a day, have been replaced by 16 electric arcs, costing only 63·6 francs a day, giving an economy of 30 per cent., with 3½ times the amount of light. In Paris, however, gas costs twice as much as in London, and is of poorer quality, and, in order to correct the cost to London prices, the cost would be 35 per cent. greater than London gas.

The price of the Gramme machines used with Jablochkoff's candles is at present £400 for the size working 16 candles; the fittings of each lamp cost £8, and the two conductors together 3s. 6d. per yard. The expenses of fitting up are to be added, and the prices of Paris for workmanship are lower than in London. Besides these items, an engine of 20 horse-power must be provided. The hourly cost of working is given as 8s. 8d. per machine, or 6½d. per light. Each single light consumes one horse-power per hour. Mr. Sprague therefore puts the hourly cost per light at 8d.

In the Lontin system, the first cost is less, and the working expenses are also to some extent less. A 12 horse-power engine is employed for the lights at the Gaiety Theatre, London. The value of the electric light is given as equal to 100 Carcel lamps for Lontin's regulators, and 80 for Jablochkoff's candles. The value of the Carcel lamp is given by Mr. Sugg as 9·5 of our standard candles. This gives 950 candles for the value of the Lontin light, and 760 for Jablochkoff's, both being naked. These lights are enclosed in opal globes, which are stated to absorb one-third of their power. The best experiments I believe show that—

Plain glass absorbs	..	10	per cent of the light.
Ground " "	..	30	" " "
Opal " "	..	60	" " "

These ratios would give the actual illuminating value o the electric light as 300 standard candles.

Ordinary gas, properly burned, will give at least the light of 14 candles for five feet per hour, that is to say, 1,000 feet give for one hour a light of 2,800 candles at a cost of, say, 3s. 4d. Assuming that the electric candle gives a light equal to 300 standard candles, and that its cost per hour is only 8d., the cost of the same 2,800 candles is 6s. 2½d., or nearly twice as much as gas for the same quantity of light.

THE LORENZ TELEPHONE CALL.

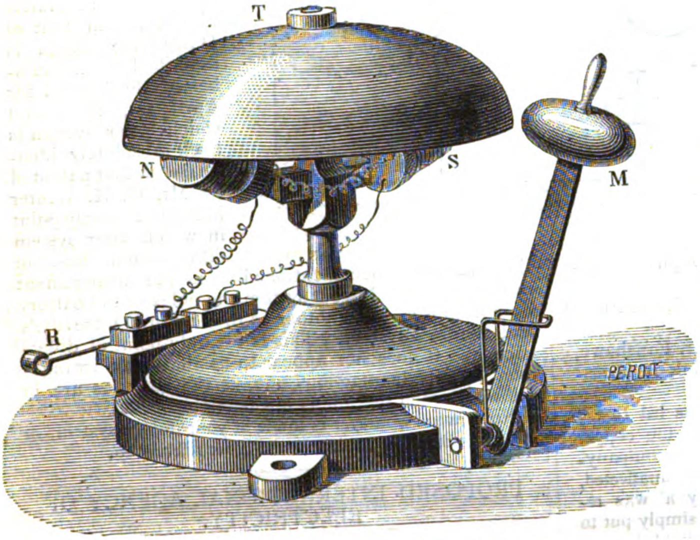
THE following description of this alarm, or call bell, is taken from the recently published treatise of M. Alfred Niaudet-Breguet, civil engineer, Paris, to which we have before drawn the attention of our readers :—

The apparatus, represented by the figure, is the transmitter of M. Lorenz. The magnet N S, is placed coincident with a diameter of the gong or bell of steel T. When, by means of the hammer M, pushed by a spring, the gong is struck in a direction across that of the magnet, the vibrations have their maximum amplitude in front of the poles, and induction currents, relatively strong are generated in the coils placed on the poles of the magnet. These currents are sent to the corresponding station, and are there received in the Bell telephone slightly modified—the bobbins being more powerful than in ordinary telephones, and a resonator being also added to them. This resonator is a long cone

of white iron, truncated at its top, the small end being inserted close to the telephone diaphragm.

In order that the resonator should give the best results it should be tuned over the bell of the transmitter and regulated in length accordingly.

This call gives out sounds easily heard throughout a workshop. We have proved that, with a little attention, it can be heard at a distance of 10 or 12 metres in an open concert hall, and at 5 or 6 metres when the hall is filled with the public. It must, therefore, be admitted that the Lorenz call yields an alarm sufficient for a great number of cases.

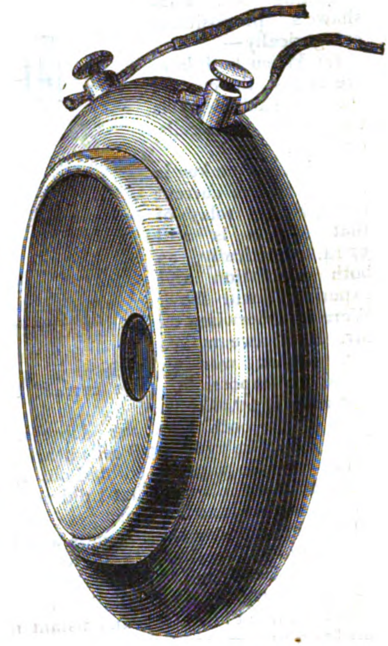


THE LORENZ TELEPHONE CALL.

The resonator telephones can otherwise serve for conversation in a similar manner to the ordinary ones. It should be stated that the bell transmitter has a commutator (not well shewn in the figure) which puts the apparatus habitually on short circuit. When, therefore, one wishes to call, it is necessary with one hand to press upon the commutator in order to put the apparatus in circuit, and with the other hand to strike the bell with the hammer.

THE WATCH TELEPHONE.

THIS form of telephone, as will be seen from the illustration, takes its name from its likeness to one of the old-fashioned "turnip" watches. The figure shows its full size, and it is the smallest kind of Bell telephone yet made. The magnet is bent into a circular form, and the coil is seated upon one of its poles, the planes of the magnet, coil, and diaphragm being all parallel to each other. The articulation is as distinct as with the larger telephones. This convenient form of telephone, which can easily be carried in the pocket, is a design of M. Alfred Niaudet-Breguet, Paris, to whom we are indebted for the illustration.



THE WATCH TELEPHONE.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In reply to Mr. Fanshawe's letter in your impression of 1st ult. on "some errors and mis-statements" in my paper on "A New System of Duplex Telegraphy," I beg to make the following remarks.

Owing to an error in working out the formula on page 87 (*Telegraphic Journal*, April 15th, 1877), the values of A and B were wrongly given, on page 86, as 39 and 1461, instead of 40·78 and 1459·22. Taking these figures, it will be seen that

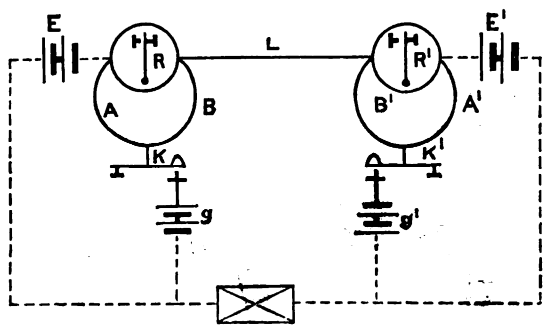
$$\frac{A}{B} = \frac{33·33}{1192·83} = \frac{40·78}{1459·22}$$

The error here is therefore only apparent.

I do not see how Mr. Fanshawe gets 5·1 instead of 8·3 cells as the strength of the current that E sends to the line on depressing K. I have carefully gone over the calculations again, taking the corrected values of A and B, and find that 8·275 cells is the exact strength. Will Mr. Fanshawe kindly look into this again and tell us how he arrives at his figures.

Mr. Fanshawe thinks me wrong in saying that the strength of the signal is the difference between (to be exact) 57·14 and 34·48 cells; but if he will read the passage again carefully he will see that I am quite

correct. When the system is at rest the current in R′ is 57·14 cells, and when K is depressed it falls to 34·48 cells. In the one case the tongue of R′ is held away from the contact stop by a force of 57·14 cells, and in the other by a force of only 34·48 cells. Now, as the tongue is so adjusted that its tendency towards the contact stop is just counterbalanced by the opposing force of 57·14 cells, it follows that 34·48 cells are entirely unable to restrain it, and consequently it falls over with a force which is the difference of the two, or 22·52 cells.



Taking Mr. Fanshawe's propositions categorically—

(1) When both keys are at rest, the current through each relay is the $\frac{1500}{2100}$ths of 80 cells, or 57·14.

(2) When one key is depressed, the current through the relay of that station is still 57·14, practically, as both calculation and experiment will show. Were it otherwise, as Mr. Fanshawe makes out, duplex working would be impossible. The current through the distant relay is 34·48 cells.

(3) When both keys are depressed, the current through each relay is 34·48 cells nearly.

The error on page 87, pointed out by Mr. Fanshawe, is so obvious a misprint that I did not think it necessary to correct it at the time.

I may mention that some months ago I was led to try the effect of substituting for earth at K and K′ the copper and zinc poles of two batteries as shown in the accompanying figure. On depressing the key K, R was unaffected, while the current in the line and distant relay R′ was reduced to a greater extent than when K was simply put to earth. In other words, the substitution of a suitable battery pole for earth had the effect of increasing the strength of the duplex signals. A like effect was produced on depressing K′, R′ was absolutely quiescent, while R was closed with increased force. I hope soon to try this modification on an actual line, and will be happy to communicate the results. I am now engaged in determining the proper proportions that should exist between the batteries E and g, and E′ and g'.

In conclusion, I would be glad to know if Mr. Fanshawe has tried my system in India, and with what results. If he would kindly communicate them through your esteemed Journal he would greatly oblige me.

Yours faithfully,

J. J. FAHIE.

Persia, 25th September, 1878.

[We have not examined the improved duplex system very carefully, but we are inclined to think that no advantage is gained by thus dividing the batteries, that is to say, if g and g' were added to E and E′, instead of being put in the earth circuit, the signals would be almost, if not exactly as strong. We shall be glad, however, to hear further on the subject.—ED. TEL. JOUR.]

F.—We have done as you wished, and the reply we have received is:—"No new duplex system is wanted." Although we regret that you should be disappointed, at the same time we must point out that such a reply seems to us to be inevitable. It is hardly likely that a new system, unless it is very much superior to the one at present in use, would be employed either as an accessory to, or as a substitute for, the existing system; to make such a change would either necessitate the reconstruction of the existing apparatus or would still further increase the variety of instruments in use, which variety is at present, to say the least, quite as great as is convenient. With reference to the advantages which you claim for your system, we must point out that, as far as we are aware, the only portion of Stearns' apparatus that is employed in the system you refer to, is the condenser; the differential method, which requires only one rheostat at each station, and which is worked with any ordinary single current key and without a transmitter, being the arrangement universally employed.

We must also point out that your system is almost absolutely identical with that of D'Infreville, which is described in the number of the Journal for April 1st, 1878, and which latter system is itself absolutely identical with that patented by Mr. G. K. Winter in 1873. The only point in which your system differs from those of the two gentlemen mentioned, is in the arrangement of the batteries. In your system the poles of the battery do not oppose one another as they do in D'Infreville's and Winter's system. This is the only point of difference, and it does not appear to us that your arrangement is an advantageous one, as the batteries are in full work when the line is not being operated.

No mention whatever is made of your duplex system, or of your method of testing in the book referred to.

PROPOSED INTERNATIONAL AGENCY OF ELECTRICITY.

A PROJECT originating with Count Hallez d'Arros is on foot in electrical circles in France, which has for its aim the establishment of an international electrical agency for encouraging the applications of science to practical life, and assisting their popular use by financial means. A museum of electrical apparatus, to which the public will have daily access to see the demonstrations, a library, a counting house and enquiry office, will be established in a central position in Paris, and the journal *l'Electricite* will give publicity to the results of the agency. The support of home and foreign constructors is requested; and any apparatus deposited by them in the museum will entitle them to a proportionate share in the concern. We gladly make known the scheme in England, and we shall give it all the co-operation that we can.

Reviews.

Electricity and Magnetism. By FLEEMING JENKIN, F.R.S.S., L. & E., M.I.C.E., Professor of Engineering in the University of Edinburgh. Fourth Edition. London: Longmans, Green, and Co. 3s. 6d.

PROF. FLEEMING JENKIN's text book on electricity and magnetism is too well known to call for much remark from us. It is the work of an eminent electrician, and a writer who treats his subject in an original and masterly manner. All English electrical text books prior to its appearance fol-

lowed the same hackneyed groove, and employed the same familiar illustrations; but this of Prof. Jenkin, if it displayed and still displays marks of haste in its preparation, showed also a plan and treatment founded on an intelligent grasp of the whole subject, and not on an ingenious compilation. The new edition is an exact reproduction of former ones, with an appendix on the telephone and microphone added.

In referring to the fact that a very thick iron diaphragm will serve for the telephone, Prof. Jenkin says "The word *bend* may be quite inapplicable to such a case, but the surface opposite the magnet does certainly advance and recede, or it would not transmit sound to the air in contact with it. This alternate advance and recess would take place if instead of a $\frac{3}{8}$ plate we had a rod many feet or many yards long. A far more singular fact has been discovered by many observers, namely, that non-magnetic, and even non-conducting substances might be used instead of a ferrotype disc in the receiving instrument; and, lastly, that the receiving instrument will work, though very feebly, with no disc whatever. In this case it seems clear that the Page effect, as it may be called, *i.e.*, the noise made by the magnet itself as its particles rearrange themselves with each change of stress, is the source of the sound heard. This sound becomes articulate as soon as its increase and decrease follow the increase and decrease produced by the voice at the sending end. It is obvious that when the currents sent are those due to Bell's disc, the sound from the Page effect must approximately at least correspond with those which the ferrotype receiving disc would give off. Thus when the ferrotype receiving disc is present we hear at least two simultaneous voices, the voice of the disc, which is strong, and the voice of the magnet that is weak. When for the ferrotype disc we substitute a wooden plate, this plate will act as a sounding-board for the Page effect. When the plate is a conductor, currents will be induced in it by the change in the magnetic field, and these will tend to move the plate in such a way as to give a third source of sound which might be called the Ampère effect. A fourth source may be due to the sound produced in the wire itself as the current changes in intensity; this sound was first observed by M. Delarive, and his observations have been lately confirmed by Dr. Ferguson in Edinburgh."

This is all admirably clear and a good example of Prof. Jenkin's talent for expounding scientific results. We should have liked to give his account of the experiment of Mr. Gott at St. Pierre, in which the coil of a siphon recorder suspended in a magnetic field was used as a telephone, but we have not the space. In regard to the nasal tone of the telephone, Prof. Jenkin is of opinion that the disc fastened at its periphery is not free to follow the impulses of the voice with perfect truth, but has peculiar modes of vibration of its own which modify the sound. The disc, free at its edges in Niaudet's form of telephone, is a better articulator perhaps for this reason.

In speaking of the microphone, Prof. Jenkin cites Prof. Tait's calclulation that the telephone currents are a thousand million times less than ordinary telephone currents, and infers that if sound vibrations are employed to modify the resistance in a telegraphic circuit including a telephone, this telephone will produce a corresponding sound provided the change in resistance amounts to one-millionth of the resistance of the whole circuit—a fact which enables us to comprehend the marvellous action of the microphone and the Edison carbon telephone. By a singular omission no mention whatever is made of the microphone receiver of Prof. Hughes.

Le Telephone, le Microphone, et le Phonographe. Par LE COMTE THE DU MONCEL, Membre de l'Institut Paris Libraire. Hachette et Cie. Illustrated with 67 Woodcuts.

ANYTHING from the pen of Count du Moncel is sure to be first rate, and this latest volume of Hachette's *Bibliothcque des Merveilles* is no exception to the rule. The recent scientific marvels of which it treats have not had a more eloquent and enthusiastic expounder and student than him, and the best fruits of his literary art and scientific skill are to be found in this volume. He begins with the earliest history of the subject and ends with the latest theories and results. All the apparatus of the telephone, the newest forms of microphones and phonographs, are fully illustrated and described, and the explanation of the microphone, in which work M. du Moncel has had so large a share, is very full and exhaustive. We would recommend an early translation of this book into English.

Notes.

MR. EDISON'S representatives in this country are so inundated with letters of inquiry that it is almost impossible to open them.

WE have authority for stating that the Edison mode of electric lighting is by the incandescence of a resisting metal.

IT is proposed to bring out at an early date a large "Edison Electric Lighting Company," with a view to filling the *immediate* demand for electric light (until Edison's system is ready) with the other means at command.

THE TELEPHONE.—We are happy to see that the French Jurors have recognised Professor Graham Bell as the chief inventor of the speaking telephone by awarding him a grand prize.

WE hear that the Bell Telephone Company, London, are about to take action against the Carbon Telephone Company, London. The same company also give notice that they will require an annual payment of £2 per telephone (the first year to be paid in advance) from all parties using telephones without paying a royalty to the Company.

WE also learn from the *Operator*, U.S., that action has been taken by the Bell Telephone Company against the American Speaking Telephone or Gold and Stock Company, both of New York, to decide whether Pro-

fessor Bell's patents include the principles of the other telephones used by the latter company. The best patent lawyers in America have been retained on either side, Mr. E. N. Dickenson, of New York, who appeared for the Western Union in the recent quadruplex suit, and Mr. Chauncey Smith, of Boston, being for the Bell Telephone Company, and Mr. George Gifford, who acted for Professor Morse in his suits with Bain and others, being the leading counsel for the Gold and Stock. The suit is brought in Boston, the New York Courts being so charged with cases that the trial might be postponed for four or five years. Two months has been granted the Gold and Stock to file an answer, and the trial will then probably take place; but it is thought that the case will not be decided in less than two years. This trial will probably sift out the share of merit belonging to each of the claimants of telephone inventions.

AN improved mechanical telephone has been patented in America by Mr. Schuyler, S. Parsons, and others. It consists of a cloth or textile diaphragm mounted on an open wooden case. The main wire is connected to the diaphragm by a number of smaller branch wires. It is hung from insulators made of sheepskin, placed in a frame with a central opening, the frame and sheepskin being slitted, and the sheepskin strengthened at the slit.

IN our review of Professor Fleeming Jenkin's "Electricity and Magnetism," in this number, we give an interesting extract on the theory of the telephone.

IN the *Archives Neerlandaises, tome XIII., 3me liv.*, is to be found an account of experiments made to determine the strength of the currents traversing the circuit of a Bell telephone in action. A sound composed of 880 vibrations per second, causing the diaphragm to vibrate with an amplitude of one-thousandth of a millimetre, produced currents in the circuit whose intensity was equal to 0·0000792 electro-magnetic units. The resistance of the circuit was 70 Siemens' units. The results were determined by the decomposition of water. Sound waves executing 440 vibrations a second produce 880 currents a second, which are capable of decomposing 748 millionths of a milligramme.

THE following are the principal results of Mr. W. J. Miller's experiments on the mechanical transmission of sound by stretched wires and diaphragms, as published by him at the Dublin meeting of the British Association :—

In general, greater volume of sound accompanied increased depth of the rim or mouthpiece round the stretched diaphragm, but the sounds were hardly so distinct as when the rim was kept shallower.

The wire was usually attached to the centre of the disc, but in some cases good results were got when the wire was led through a cylindrical hollow piece of wood, and terminated *close* to the disc; indeed, a hollow piece of wood *without* a disc did very well. High-pitched voices are more easily heard than deep, strong voices. The wires (of copper) No. 23 and No. 40 as a rule required to be more or less tightened up to a degree varying with the heaviness of the wire. The sound is increased with a tight wire, and the volume of sound appeared to be increased with a heavy wire; thus with No. 8 telegraph wire the sounds were fuller and stronger than in thinner wires, and, probably owing to its high tenison, faint sounds were more readily transmitted. In all cases the individual voice could be easiiy distinguished, though modified more or less by the structure and material of the mouth and ear pieces.

THE MICROPHONE.—A very neat portable microphone has been devised by M. Trouvé, Paris. It resembles a small cylindrical hand lantern with a door in its side; the candle being replaced by the upright stock or pencil of carbon, which is supported by a carbon floor and ceiling.

AMERICAN makers are said to be shy of making microphones, because of Edison's carbon telephone patents. Yet very good proof of the novelty of the microphone to Americans is to be found in the fact that experimenters there are still being surprised over the earliest of its feats.

A MECHANICAL microphone, or rather telephone, is announced from Cincinnati. Mr. Israel D. Jewett, druggist, St. Omer, Indiana, has invented a contrivance called an "agaphone," which is said to be capable of transporting sounds, music, speech, and watch-ticks over a wire nearly half a mile long without the aid of electricity. It has not yet been patented, and the explanation is not forthcoming; but it may turn out to be an improved "string telephone."

THE PHONOGRAPH will henceforth be sold in America to all purchasers, without any royalty to the Phonograh Company, for 100 dols. (£5) or 200 dols. (£10), according to the finish of the instrument.

M. BOUILLARD, the eminent French *savant* who lately pronounced the phonograph a ventriloquial fraud and the microphone an acoustical humbug, has probably had his doubts set at rest, for at the *séance* of October 7th, Count du Moncel again exhibited the "singing condenser" and the phonograph before the entire Academy, leaving it to the members to make the experiments themselves.

THE TELEMACHON. — By his electric telemachon, Mr. William Wallace, electrical manufacturer, of Ansonia, Conn., U.S., is enabled to transmit power from the Naugatuck River to his factory, a quarter of a mile off, with a loss of some 20 per cent. of the current. The telemachon consists of a dynamo-electric machine, for transforming mechanical power into electricity, and an electric motor, which reverses this operation, and turns the current into power. It is this apparatus that Edison alludes to in his account of his plans with the electric light. As it exists at present, Mr. Wallace's dynamo-machine only feeds eight separate electric lights, each being reputed to equal 4,000 candles.

THE Liverpool city authorities intend applying to Parliament for powers to adopt the electric light for general illumination, and the contemplated purchase of the gasworks is put off.

LUMINOUS PAINT (Patent No. 4152, 1877).—W. H. Balmain involves the novel idea of mixing paints and varnishes with a phosphorescent salt (such as a mixture of lime and sulphur). This composition will store up daylight and give it out by night. Practically, Mr. Balmain applies it to clock faces, but his patent claims its use for all kinds of lighting purposes. Rooms may be painted with and streets coated so as to become self-luminous, ships' buoys, and all manner of things.

THE *American Gas-light Journal* thus paraphrases the report of Mr. G. H. Stayton, the surveyor of the Chelsea Vestry, on the electric-light: "When electricity can supersede gas as a means of illumination, both in price and quality of light, it will probably be adopted." Probably.

HANLEY SKATING RINK has again opened for the season, with an electric light of 500 candle power, costing only 3d. per hour.

WE are glad to learn that Dr. Alexander Muirhead has obtained an excellent duplex-balance with Muirhead's Artificial Cable at the Madras end of the Eastern Extension Company's Madras to Penang Section. Dr. Muirhead is now on his way to Penang to establish the balance there, and so complete the arrangements for duplex working.

MR. THOMAS LETTS, the well-known stationer, of 72, Queen Victoria Street, has published a series of finely-executed maps, or charts, intended as a newspaper reader's companion, or index to "Useful Knowledge." There are 230 maps in the entire series, including maps of cities and special localities. The prices, mounted on cloth and unmounted, range from 2s. 6d. to 6d. From the specimens sent us, we should say that these handy maps will be of use and interest to many telegraph engineers.

THE TELEGRAPH TO THE CAPE.—The Legislature of Cape Colony has passed an act authorising the payment of a sum not exceeding £15,000 a year for fifteen years as a subsidy in aid of a line connecting England to the Cape, and Natal has agreed to pay a similar subsidy of £5,000 a year. Mr. Thomas Watson, President of the Cape Town Chamber of Commerce, advocates in the *Times* of October 28 a land line in preference to a cable. A land line from Khartoum to Port Durtan, Natal (2,500 miles as the crow flies), would, at £200 a mile, cost only half a million as against £1,200,000 for a cable, and would, he thinks, help much to suppress the slave trade and open up Central Africa.

THE underground cable from Strasburg to Kiel, 1,200 kilometres long, is now working with complete success.

A BURNT CABLE.—Of the many curious haps and mishaps that befall submarine cables it might be deemed that injury by fire is the most unlikely. Nevertheless, the P. O. Cable across the Firth of Forth, containing four conductors, was recently interrupted by a fault, found below high water mark, which had been caused by a fire kindled with shavings when the tide was low. The gutta-percha of the core was melted away leaving the conductors in contact with the iron sheathing.

A CABLE between Alsen, Schleswig, and Fühnen, Denmark, was laid on September 28.

A THIRD edition of Prescott's "Electricity and the Electric Telegraph" is now in the press, and a second edition of his book on the Telephone is also in preparation. A good deal of new matter will appear in these new editions, particularly on the Electric Light and the Carbon Telephone, which has recently been greatly improved.

THE Eastern Telegraph Company announce the extension of their submarine system to Cyprus. The cable has been successfully laid by the Telegraph Construction and Maintenance Company between Alexandria and Larnaca, and was opened for traffic on the 18th inst. This puts Cyprus in direct telegraphic communication with Malta, Gibraltar, and England; also with France, Italy, Greece, and Constantinople; and on the other side with Egypt and India. This company's recent extensions to Besika Bay, Crete, Constantinople and Cyprus have been established by agreement with her Majesty's Government, and are worked throughout by telegraphists under the company's control.

THE Cienfuegos to Santiago section of the Cuba Submarine Company's cables repaired last April is again interrupted, but traffic is kept up by the duplicate line.

THE Eastern Telegraph Company have sent out several hundred miles of cable with core sheathed in brass tape, to test whether or not it will withstand the teredo.

THE CASE OF MR. HERRING.—Mr. Richard Herring, of St. Mary's Road, Canonbury, is the spirited exponent, both in lectures and pamphlets, of his battles with what he calls the *vis inertia* of the postal telegraph authorities. As far back as 1870 Mr. Herring brought before the notice of the postal telegraph department an improved Morse which marked the slip transversely, thus condensing the message and saving paper. He was told that it must be made to emboss the paper before it could be tried. He made it do so, and the instrument was tried in January, 1871, but condemned because it did not mark the signals in ink. The ink-marking type was then tried before Sir William Thomson and Prof. Fleeming Jenkin in October, 1872; but Mr. Herring was dissatisfied with this trial, alleging that the referees did not keep to the terms agreed upon. A further trial by automatic sender was then suggested by Mr. Jenkin. Mr. Herring wished that Messrs. Clark, Forde, and Co., who had already reported favourably on the instrument, should be present at the trial in his favour, while the above-mentioned gentlemen represented the postal authorities. Mr. Scudamore agreed to this; but no such trial ever came off, although Mr. Herring had incurred considerable expense in preparing for it, and engaging Messrs. Clark, Forde, & Co. On July 4, 1874, Mr. Scudamore wrote to Mr. Herring that the experiments with his instrument had now ceased, and the department had decided not to use them. Thus the department seems to have broken its promise, and to have caused Mr. Herring considerable loss in time and money. It makes no offer to reimburse him, and the legal advice which he has obtained counsels him to the remedy of a petition of right against the Crown, and opines that it is a case for a jury, by whom substantial damages might be returned. Mr. Herring would, however, doubtless be satisfied by the trial formerly arranged for being faithfully carried out now.

IT is reported that the *Great Eastern* is to be employed in the transport of cattle from Texas to London. She will carry 2,200 head of cattle and 2,600 head of sheep.

PROFESSOR GRAHAM BELL (according to the *Scientific American*) thus writes to an American friend: "If you want to know the reason why inventors are more numerous in America than they are here, come and live for six months in England. If you wish to know how it feels to be brimful of ideas and yet to be unable to have one of them executed, come to England. If you wish to know how it feels to have to wait for a month to have the simplest thing made and then be charged a man's wages for two months, come to England."

THE BUNKUMPHONE.—The bunkumphone, of American origin, is an ingenious combination of the telephone, phonograph, and other ~~phono-gritties~~, designed for the

exclusive use of financiers. It consists essentially of a metallic disc in a state of excessive vibration, and having the property of putting in movement many other discs of the same sort in our continent of simpletons, and of attracting these European discs by an action as energetic as it is well dissimulated. This disc is actuated by submarine cables, the chief of which connects the City of New York with the Institute of France. The attracting disc is of silver, and it has the weight and external appearance of a dollar. The attracted discs resemble ordinary *cent-sous*.

This apparatus is being experimented upon at this moment with great success. They have shown us at the *Figaro* office this same bunkumphone as a marvel inexplicable as the mystic cabinet of the Davenport Brothers. We have dismounted the little machine, and after having seen what was inside, we have said:—"Gogo, friend Gogo, the Frenchman is a born fool, everybody knows that; but he hasn't quite got used to American humbugs. Gogo, beware!"—*Le Figaro*, Paris.

Compound Lightning.—Mr. E. H. Pringle, in a letter to *Nature*, October 3rd, states that "compound lightning flashes," or discharges, where several flashes follow each other rapidly in the same track, are to be seen in almost every tropical thunderstorm. When the flashes succeed each other quick enough, the effect is "beaded lightning." It is singular that the electricity should collect so rapidly; for the after-flashes do not seem to be merely residual.

Longitude by Telegraph.—As a specimen of the precision now attainable in the determination of longitudes by galvanic signals, we may quote the three results, obtained at different times, and in different ways, for the difference of longitude of Greenwich Observatory and Harvard Observatory, Cambridge, Mass. They are as follows:—

	h.	m.	s.
In 1866, by Anglo-American Cables ...	4	44	31·00
In 1870, by French Cables, to Dixbury	4	44	30·99
In 1872, by French Cable, to St. Pierre	4	44	30·96

Tommasi's Relay.—We recently gave an abstract of some experiments made by M. Tommasi on the Atlantic Cable taken from the *Comptes Rendus* (bulletin of the French Academy of Sciences), an authority which ought to be trustworthy. These results did not appear to us to form any practical test of the apparatus, but we gave them for what they were worth. Mr. Weaver, General Manager of the Anglo-American Telegraph Company, however, informs us that these results are erroneous, and that the relay was a complete failure. We are not surprised at this, for it ignores the essential fact of a varying zero in submarine telegraphy, and its much vaunted sensitiveness is only exhibited through resistance—induction being absent. We have condemned this relay before, and are now not sorry to be able to expose the hollowness of its pretensions for practical submarine work.

Effect of Pressure on Disruptive Discharges in Air.—Mr. J. E. H. Gordon has been studying the effect of changing air pressure on the length of the electric spark. His apparatus consisted of an induction-coil giving a spark of 17 inches, and worked by 10 Grove's cells. The discharging tubes were 4 feet long and 3 in. diameter, with a stuffing-box at one end, in which a brass rod slid. The inner end of the rod was kept in the axis of the tube by 3 glass arms on an ebonite collar. The whole apparatus was insulated on ebonite legs. The tubes were connected with an air-pump, by means of an insulating glass tube. The pressure was given by a U gauge about 4 feet high, and the air dried by passing it through sulphuric acid. In the experiments, one tube was open to the atmosphere, and the discharging point kept at a standard distance from the ball. The other tube being nearly exhausted, experiments were begun at low pressure, a little air being let in between each observation. The discharging distance in the second was then adjusted to the shortest distance, which caused the whole discharge to pass in the first tube. On this being noted, the points of the second tube were again brought together, until the whole discharge passed between them. The mean distance of the two observations was taken. The results were:—

1. From a pressure of 11 inches upward the length of spark is inversely as the pressure.

2. Accidental circumstances materially modify the length of spark.

3. Below a pressure of 11 inches the spark is shorter than it should be by No. 1, the electro-motive force required to produce a spark of given length at low pressure being greater.

The last result agrees with Sir W. Thomson's experiments, which showed that greater electro-motive force per unit length of air is required to produce a spark at short distances than long ones. To this may now be added "and at low pressure than at high."

Elongation of a Conductor traversed by a Current.—M. Blondlot has presented to the French Academy of Sciences an account of some experiments undertaken with a view to prove whether or not there is really an elongation of a wire when a current passes in it, as Edlund and Streinitz have believed and Wiedemann has denied. This method is designed to distinguish more clearly than heretofore between the effect due to heating and that due to the current. The principle of it consists in intercalating a thin metal ribbon in the circuit, by means of stout soldered connections. Any effect due to heating will dilate this ribbon both longitudinally and transversely, so as to increase its bulk without deforming it. But the current effect, if it take place, will do so unequally in the two directions, and will consequently deform the ribbon. Any misshaping of the metallic band or of figures traced on its surface ought therefore, M. Blondlot reasons, to be due to the current, and if there be none, such a direct mechanical action of the current does not exist. With the current from ten Bunsen cells no elongation could be detected, although the arrangement was capable of showing an elongation of 0·00000025m. per metre. Ribbons of brass, German silver, and other metals were experimented on, but with the same negative result.

Atmospheric Electricity.—In a recent memoir read before the Academy of Naples, Prof. Palmieri gives the results of his 27 years experience of this subject. He is of opinion that the formation of aqueous meteors and clouds is always attended by the liberation of positive electricity; but these clouds can afterwards change themselves negatively by induction. When negative electrification is observed, it is due to perturbations resulting from discharges at distances more or less great. In dry clear air where the distribution of positive electricity is normal, the potential diminishes with increasing height, a result different to that obtained by other observers.

Conductivity of some Electrolytes.—M. Svenson (*Inaug Dissert Lund Suédois*) finds that the electric conductivity of solutions of sulphate of potash, sulphate of aluminium, the alums of soda, potash, ammoniate of iron, ammoniate of chronic (red and green), increases with the proportion of salts.

Resistance of the Electric Light.—Professor W. E. Ayrton and John Perry, of the Japan Imperial

Engineering College, find the resistance of the "voltaic arc" to be as follows:—

Number of Grove's cells in series.	Resistance of battery.	Mean resistance of arc.
60	12 ohms	12 ohms
80	16 "	20 "
123	24·4 "	30 "

The Grove cells employed were of the ordinary English rectangular form: the area of the platinum plate immersed being 13 square inches, and of the zinc plate 25 square inches. The arc was produced by a Dubosq's lamp. In these results the resistance of the arc increases more rapidly than that of the battery employed. If then the resistance of the electric light be found to increase proportionately to that of the battery, Messrs. Ayrton and Perry point out that it will follow that cells used for producing the electric should be all joined "in series," and no part in parallel circuit.

WE have received the following communication, which may have an important influence on gas shares:—

THE DAY-LIGHT STORER.—EDISON OUT-DONE.

"DEAR SIR,—For ten years I have been haunted by the idea of discovering a means of general illumination which will be within the reach of the poorest, and explode gas for ever. When I conceive a problem of this kind, I never rest until I solve it, and consequently I have never rested for ten years. The other day, while pacing my garden walk in the twilight, pondering this subject, I spied a glow-worm in the grass, and, involuntarily, I cried out, 'Eureka!' The idea had at length burst upon me. It is this. I prepare a phosphorescent salt of lime, which by day absorbs light, and by night gives it forth again, in a soft, diffused glow. I cause the walls of each room in a house to be coated with this salt, for domestic illumination, and I enact that all the houses lining a street be white-washed with it—so that as darkness comes on, the whole city, outside and in, shall be self-luminous. In this way I store up the light of day, and enable every man, for a few pence yearly, to be his own gas works, or his own electric light. The hideousness of night is banished; and burglars are unknown. I have patented this process in every civilised and uncivilised country, notably Africa, where, I imagine, the negroes will want to apply it to their persons. The nature of the salt will be revealed in due course."

It is, perhaps, necessary to say that this letter did not bear the American post-mark.

New Patents.

4007. "Mechanism and the working of electric clocks." R. H. BRANDON (communicated by C. H. Firnhaber). Dated October 10.

4011. "Arrangement of telephonic circuits." J. H. MCLURE. Dated October 10.

4016. "Electric lighting, &c." J. MUNRO. Dated October 11.

4022. "Improved arrangements for electric lighting." J. W. T. CADETT. Dated October 11.

4031. "Improved means of softening or diffusing the electric and other light." A. M. CLARK (communicated by L. Clémandot). Dated October 11.

4041. "A new and improved method of, and apparatus for, communicating rotary motion to hair brushes by means of electricity; applicable also to other purposes." W. NORTH. Dated October 12.

4043. "Improvements in the application of electricity to lighting and heating purposes and in the means or apparatus employed therein." ST. G. L. FOX. Dated October 12.

4046. "Obtaining electric light." G. P. HARDING. Dated October 12.

4047. "Obtaining electric light." G. P. HARDING. Dated October 12.

4066. "Magneto-dynamo-electric machines." J. IMRAY (communicated by the Société Générale d'Electricité). Dated October 14.

4074. "A mode of indefinitely dividing electric currents." A. ARNAUD. Dated October 14.

4075. "Galvanic batteries." J. H. JOHNSTON (communicated by W. W. GRISCOM). Dated October 14.

4079. "An improved translucent medium for reflecting, refracting, and diffusing light, capable of application to various other purposes." J. L. PULVERMACHER. Dated October 14.

4094. "Improvements connected with means and apparatus for the production, application, and regulation of electric currents." J. L. PULVERMACHER. Dated October 15.

4095. "Galvanic batteries." F. H. W. HIGGINS. Dated October 15.

4100. "Improved means of producing electricity and the electric light." F. H. VARLEY. Dated October 15.

4114. "Improvements in the method of dealing with electric currents, whereby they may be divided and distributed through any required number of circuits for lighting and other purposes. E. J. C. WELCH. Dated October 16.

4116. "Electric lightning." G. FORBES. Dated October 16.

4132. "Improvements in or applicable to electric lighting apparatus." A. S. HICKLEY. Dated October 17.

4140. "Electrical apparatus." W. SCOTT. Dated October 18.

4163. "Improvements in the application of electricity, being an imperishable substitute for carbon, and especially adapted to illumination." (J. N. ARONSON, H. B. FARNIE). Dated October 18.

4161. "A commutator for double transmission and reversion of current with contact to earth for submarine telegraphy. E. EDMONDS (communicated by le Comte E. Siccardi). Dated October 18.

4180. "Producing light by electricity."

4208. "Improved means and apparatus for electric illumination." C. W. SIEMENS. Dated October 22.

4212. "Lighting by electricity." C. T. WRIGHT. Dated October 22.

4226. "Method of and means for developing electric currents and lighting by electricity." T. A. EDISON. Dated October 23.

4231. "Apparatus for the increase and diffusion of all kinds of artificial light." F. YOUNG, C. M. DALE. Dated October 23.

4278. "Improvements in apparatus for dividing and distributing or for collecting electric currents for lighting and other purposes." E. J. C. WELCH. (Complete.) Dated October 25.

4283. "Improvements in obtaining light by electricity, and an apparatus for its application to illuminating purposes." J. E. STOKES. Dated October 25.

4290. "Improvements in the means or apparatus for igniting, regulating, and extinguishing the lights in streets and other lamps." G. GALE. Dated October 25.

4304. "A method of dividing and distributing the current produced by magnetic batteries and magneto and dynamo-electric machines into an indefinite number of separate currents equal or relatively unequal to each other in quantity or force." C. E. SHEA. Dated October 26.

4313. "Improvements in obtaining electricity and in the application thereof to the electric light and to other useful purposes." A. A. COCHRANE. Dated October 26.

4315. "Apparatus for producing light by electricity." B. P. STOCKMAN. Dated October 26.

4317. "Lamps for lighting by electricity." F. D. TILLEARD. Dated October 26.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

240. "Electric lamps." E. T. HUGHES (communicated by W. Wallace, Ansonia Co., Conn., U.S.). Dated January 18, 1878. 4d. This consists of an electric wick which dispenses with a regulator for adjusting the carbons. The carbons are in the middle of two slabs, having sharp edges parallel to each other. The arc is started at one corner of the slabs and travels along the edge till it arrives at the other corner, then comes back again, and so on, the edge of the positive carbon being eaten away and the new arc forming itself where the resistance between the wicks is less than before. A full description of this lamp is given on another page.

251. "Electric telegraph conductors." C. W. SIEMENS. Dated January 19, 1878. 6d. This consists in a means of protecting the cores of cables by enclosing it in a sheathing of metal tape, the outer sheathing of hemp and wire being applied over all where required. The tape, which may be of copper, is applied by a revolving bobbin or bobbins so that each turn of it overlaps on the last, and it is closed up by being passed through a die or between grooved pressing rollers. Conductors of large core for conveying electric light currents are advantageously sheathed in this manner, the sheath acting as a return wire.

275. "Semi-automatic apparatus for transmitting telegraph messages with the Morse system." T. J. SMITH (communicated by M. le Comte Emile Siccardi, Turin, Italy). Dated January 19, 1878. 10d. This consists of a sending key with two finger levers, one for dots and the other for dashes, whereby the duration of the dot and dash signals is automatically controlled, independently of the clerk.

291. "Communicating signals on telephonic circuits." JOSEPH HENRY MCLURE. Dated January 23, 1878. 6d. This consists in a combination of the telephone and telephone call whereby the mere position of the telephone operates the switches so that the call bell is alone in circuit, or the telephone, or both, as the case may be. In one form of telephone under this patent the call bell circuit is closed by touching a press button on the stem of the telephone, and the bell sounded.

307. "Telephones." DANIEL PIDGEON. Dated January 23, 1878. 2d. This describes a magneto-electric telephone call, combined with the telephone itself. The magnet of the telephone can be made of a horseshoe form, and a small coil rotated by hand is placed between the poles as the armature in which are generated the magneto-electric currents. The current is rapidly interrupted and the effect is to cause the distant telephone to give out a loud sound. Thus the "call" forms part of the telephone itself and no battery is required. *Not proceeded with.*

308. "Galvanometers, &c." L. A. BRASSEUR and M. S. W. DE SUSSEX, Brussells. Dated January 23, 1878. 6d. This consists in a relay for long submarine cables, which combines with the needle or the galvanometer a device which will close a local circuit at every increase of the line current, whatever be the last position of the needle of the galvanometer. The needle carries a light cross arm, from one end of which a vane dips into a pan of fluid, and from the other end a point is brought very close to the surface of a pan of mercury. The local battery is connected up to these fluids, and the least motion of the needle causes the point to make contact with the mercury, thereby closing the local circuit through the cross arm.

312. "Submarine telegraph cables." HENRY CLIFFORD. Dated January 23, 1878, 4d. The object of this is to guard the cores of submarine cables from insect ravages. A riband of felt, calico, or other fibrous material is coated with a mixture of resin, resin oil, or marine glue, and while soft it is caused to adhere on one or both sides to wire gauze, sheet brass, or Muntz metal, &c. It is then cut into tapes, which are laid round the core helically so as to overlap. The metal should be entirely covered with the tape, or pitch, or oil. The ordinary sheathing is then applied.

375. "Manufacture of insulated telegraphic conductors."—EDWIN T. TRUMAN. Dated January 29, 1878. 4d. This consists in enclosing india-rubber core in a lead tube, then turning it into vulcanite by heat and pressure. In this way a flexible vulcanite core is produced. Paraffin, ozokerit, or other waxes may be used to mix with the india-rubber, the compound being afterwards vulcanised. Gutta-percha and balatah may be also used in place of or along with rubber. The lead or other flexible material may also be used to cover other hard and brittle coverings, such as parkesine.

405. "Apparatus for reproducing musical and other sounds by electricity." A. M. CLARK (communicated by C. L. Weyher, Paris). Dated January 30, 1878. 2d. A simple make and break musical telephone is here described with a diaphragm for transmitter and electro-magnetic receiver. *Not proceeded with.*

408. "Controlling and localising electric currents." LUIS DE BEJAR Y O'LAWLOR. Dated January 31, 1878. 10d. This consists of a modification of the auto-kinetic system (described in patent No. 1303, 1876), whereby a number of radial stations can communicate with a central station without interference or tapping of the message.

City Notes.

Old Broad Street, October 30, 1878.

The tenth ordinary general meeting of shareholders of the Brazilian Submarine Telegraph was held on the 25th inst., at the Cannon-street Hotel; the Right Hon. Viscount Monck in the chair. The report stated that the Directors recommended the declaration of a final dividend of 2s. 6d. per share, making a total dividend of 5 per cent. for the year. This would absorb £16,250, leaving a balance of £55,675. Of this amount £50,000 had been placed to the reserve fund, increasing that fund to £170,000, and £5,675 had been carried forward. The Chairman said there were three questions with which they had to deal. First, the gross income; second, the expenses; and third, the net income. The income for the half-year with which they were

now dealing was £72,086, as compared with £66,028 in the last half-year, which showed an increase of £6,058. That was, however, hardly a fair comparison to make, as experience showed that the second half-year was usually less productive than the first. As compared with the first half of 1877 the increase was only £1,976, but that was so far satisfactory, because it showed that, notwithstanding the long-continued depression in trade, the traffic of the company had increased to a considerable extent. The increase of £315 on the expenses was due to the fact of their staff having taken the furlough with a free passage home after five years' service, which was in accordance with the agreement under which they were engaged, and after the uniformly good conduct of that staff he did not think shareholders would begrudge that expense. The manner in which the balance was disposed of, after paying 5 per cent. dividend, was by adding to the reserve fund, so as to render the 5 per cent. perpetual, and he did not think 5 per cent. in perpetuity a bad return for money invested. At any moment, also, they might be called upon to repair the shore end of the cable at Lisbon, and Directors were anxious to retain in hand sufficient funds to pay for that outlay. The question of their right to suspend the payment of their thirds under the agreement with the Western Brazilian Company was at present in dispute. Nothing had been paid under this head since February last, and the money had been carried into the accounts of the Company. The construction of the contract was a matter for lawyers, and they, therefore, thought it wise to retain possession of a sum of money to enable them to pay the Western Brazilian Company their thirds, should the matter be decided in that Company's favour. He moved that the report be received and adopted. Sir James Anderson seconded the motion, which, after some discussion, was carried unanimously.

The third ordinary general meeting of the members of the West India and Panama Telegraph Company was held on the 23rd inst., to receive the report and accounts for the six months ending June 30th last, and to declare dividends. Mr. C. W. Earle in the chair. The report and accounts having been taken as read, the Chairman in moving their adoption said: The revenue account now presented showed a greater balance of earnings over expenditure than was shown by any previous accounts. But in considering the accounts and inquiring whether it was thoroughly satisfactory as regarded the progress of the Company, there were some features which would not altogether afford a satisfactory reply to that question. It would be observed that the expense of repairing the cables was very much below what it had hitherto been. The average cost of repairs of cables was about £5,000, but this half-year they were something under £2,000. The difference between these two figures turned the scale, and made what would otherwise not have been such a good report, the best the Directors had presented. The cost of repairs was not under control and quite depended upon the winds and the waves. As to the items in the expenditure account, it was satisfactory to observe that there was a general and substantial decrease in them, which could only be attributed to constant watchfulness upon the general management of the company. Every item, indeed, was carefully checked. On the other side of the account there was, as noticed in the report, a falling off in the receipts, which was no doubt partly attributable to the very general depression of trade. That might of course only be a passing influence, and the tide must turn sooner or later, and then the Company would recover what they had lost under that head. With regard to the "coding" of messages, he feared there was little hope of improvement in the receipts of the Company being effected by that system. On applying to the colonial authorities, as an inducement to them to grant the largely increased rate, the company offered to reduce the minimum from ten words to one, and charge by the word; and it was very questionable, if that concession had not been offered, whether the company would have been allowed to increase the rate. However, the system of coding had been brought to such a pitch of excellence that the average number of words in a message had fallen off very much, although every means had been taken to see that their agents did their work properly. A statement had been prepared, which any shareholder could see at the company's offices, as to the amount of work they had to do in the West Indies. This was the second time since the present Board had been in office that the half-yearly meetings were connected with events in the West Indies, which caused a good deal of alarm and excitement. Two years ago, while sitting in that room, the Directors, and the Government also at the same time, were receiving telegrams as to the state of affairs in Barbadoes, where the negroes were then rioting and doing damage; and in the beginning of the present month a similar occurrence took place in a Danish colony in the West Indies. The details were not yet known, but they had heard enough to know that their telegraph had been instrumental in saving the property and perhaps the lives of a great many people.

By the Company's Cable the Governor of St. Thomas had been summoned, with his soldiers and men-of-war, to protect women and children and property from the pillage that was going on. Considering the important services the Company rendered to the Colonies, it seemed almost ridiculous that the Board should from time to time have to meet the shareholders with the payment of 1 per cent. dividend only and a very inadequate reserve fund. The Company had originally been formed with a capital of £660,000, which was now nearly doubled, the Company having been afterwards induced to include a greater number of islands and it having been found necessary in consequence to duplicate the system of cables. He considered, however, that that capital had been usefully augmented, and the colonists had no cause to complain of the company. The average revenue per mile of the six principal cable companies was 39·5 per mile, while this company's was 38·19, and that was really the cause of the company's present position, and it was not a revenue adequate to keeping up a proper reserve fund. A representation to this effect had been made to the Secretary of State, who had promised to give the matter full and fair consideration. He (the Chairman) then moved:—"That the directors' report and accounts to the 30th June, 1878, be, and they are hereby adopted, and that dividends be declared payable as follows—namely, on First and Second Preference Shares at 6 per cent. per annum, and on the ordinary shares 1 per cent., free of income-tax. —Mr. Ford seconded the resolution.—The Chairman, in reply to Mr. William Abbott, stated that one satisfactory feature in the code system was that it was helping the mercantile public in the West Indies, but he regretted the constant and regular decrease from month to month under that system which was working prejudicially to this country. With reference to the Central American Company, the lines opened by that company and the South American Company were so far from being perfect that if the Central American Company were resuscitated it would not be of much use, and the board had not hitherto been able to make any progress in that direction. The Chairman also said in the present state of matters the company would not gain by laying their own cables, as the lines of the Central

American Company were all broken down.—The resolution was then carried unanimously, and a vote of thanks to the Chairman terminated the meeting.

The report of the directors of the Eastern Extension, Australasia, and China Telegraph Company states that the gross earnings of the Company for the half year have amounted to £135,482. The working expenses, cost of repairs and maintenance of cables, new land lines and instruments for the establishment of duplex working on the Madras-Penang Cable, payment of income tax, interest on debentures, &c., amounted to £61,222, leaving a balance of profit for the half-year of £74,260. Two interim dividends of $1\frac{1}{4}$ per cent. each, amounting to £49,937 10s., have been distributed, leaving the sum of £24,323 to be carried forward to the next half-year. The Telegraphic Conference, referred to in the last report, was held at Melbourne in May last, when the question of duplicating the Australian cable was fully discussed, the result being that the Governments of Victoria and New South Wales were empowered to enter into an agreement with the Company for a second cable between Singapore and Australia for an annual subsidy of £32,400, payable for twenty years. Negotiations have since been carried on with the representatives of the Governments, which the directors have the satisfaction of stating have resulted in an agreement on the above basis, the terms of which will be submitted for confirmation to the extraordinary general meeting to be held at the conclusion of the ordinary general meeting, together with resolutions empowering the directors to carry the same into effect. The importance of this duplication as a protection of the Company's traffic will, it is believed, be apparent to the shareholders. The fresh capital required is £660,000, which the directors propose to raise by the issue of debentures redeemable within twenty years. The meeting is announced for the 6th prox.

The annual report of the Western Union Telegraph Company shows the business of the year has resulted in revenue accruing to the company 9,335,810 dols., expenses, 6,173,810 dols. The net profits (after reserving amount sufficient to meet the claims of the Atlantic and Pacific Telegraph Company under existing agreements) being 3,161,999 dols. This has been applied in four quarterly dividends of $1\frac{1}{2}$ per cent. each, to interest on debt 453,741 dols., to sinking fund appropriations 79,970 dols., leaving surplus of net revenue for the year over dividends, interest, and sinking fund appropriations of 524,561 dols. From this surplus there was appropriated for construction of new lines and erection of additional wires 216,320 dols., for purchase of sundry telegraph stocks (other than Atlantic and Pacific), patents, &c., 44,758 dols., the balance of 263,482 dols., together with the balances of previous years, being applied to the amount due on account of the purchase of the Atlantic and Pacific Telegraph Company's stock.

The Eastern Telegraph Company announce the extension of their submarine system to Cyprus. The cable has been successfully laid by the Telegraph Construction and Maintenance Company between Alexandria and Larnaca, and was opened for traffic on the 18th inst. This puts Cyprus in direct telegraphic communication with Malta, Gibraltar, and England; also with France, Italy, Greece, and Constantinople; and on the other side with Egypt and India. This company's recent extensions to Besika Bay, Crete, Constantinople, and Cyprus have been established by agreement with her Majesty's Government, and are working throughout by telegraphists under the company's control.

"We have received," says the *Daily News* of October 23rd, "the following from the secretary to the Eastern Extension Telegraph Company, and trust that the hopes held out will be realised, for the necessity of duplicating the present service with the Australian colonies is paramount:—'Referring to the paragraph in your money article of to-day, giving a quotation from the *Melbourne Argus* of the 2nd September to the effect that the negotiations with this company for the proposed duplicate cable to Australia had been broken off, I beg to inform you that the difficulties therein referred to have since been removed. We have to-day heard from Colonel Glover, the company's representative in Australia, that he expects to be able to advise us in a day or two of the ratification by the various Legislatures interested of the contract for the duplicate cable.'"

The *Daily Telegraph* reports that Sir Henry Layars has applied to the Porte for authority to lay a cable between Cyprus and Beyrout.

The Secretary of the Telegraph Construction and Maintenance Company Second Bonus Trust notified that the seventh distribution will be at the rate of 2s. 3d. per £5 certificate, and will be paid on and after Nov. 1, on presentation of Coupon No. 7, at Messrs. Barclay, Bevan, and Co.'s, 54, Lombard Street.

The fall in the prices of gas shares since our last issue has again been considerable, and the principal stocks show a depreciation of about 15 to 20 per cent. when compared with prices a month ago. To-day Gas Light and Coke "A" Ordinary fell 5, to 135, 145; ditto, Five per Cent. "A," Fourth Issue, $\frac{1}{2}$, to 12, 13; Imperial Continental, 5, to 135, 145; and Bombay, $\frac{1}{2}$, to 4, 5.

The electric light continues its steady progress. Mr. E. J. Reed, writes to a contemporary, that "A powerful company is in course of formation, and will be registered without delay, to be entitled 'The National Electric Lighting Corporation, Limited,' for the purpose of supplying the Rapieff and other systems of electric lighting." This news will hardly tend to an improvement in the value of gas shares. Mr. Reed's friend, Mr. C. Noel Hoare, of 25, Abchurch-lane, E.C., has been good enough to undertake to act on his behalf until his return from Japan (whither an official engagement calls him), and he, Mr. Hoare, will be happy to attend to the communications of all those who may desire to interest themselves in this public question.

The following are the late quotations of telegraphs:—Anglo-American, Limited, 58-$58\frac{1}{2}$; Ditto, Preferred, $84\frac{3}{4}$-$85\frac{1}{4}$; Ditto, Deferred, 32-$32\frac{1}{2}$; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, $6\frac{3}{8}$-$6\frac{5}{8}$; Cuba, Limited, $7\frac{3}{4}$-$8\frac{1}{4}$; Cuba, Limited, 10 per cent. Preference, $15\frac{1}{4}$-$15\frac{3}{4}$; Direct Spanish, Limited, 2-$2\frac{1}{2}$; Direct Spanish, 10 per cent. Preference, 10-$10\frac{1}{8}$xd.; Direct United States Cable, Limited, 1877, $12\frac{1}{4}$-$12\frac{3}{4}$; Eastern, Limited, $6\frac{7}{8}$-$7\frac{1}{8}$; Eastern, 6 per cent. Debentures repayable October, 1883, 107-110; Eastern 5 per cent. Debentures repayable August, 1887, 98-100; Eastern, 6 per cent. Preference, $11\frac{1}{4}$-$11\frac{1}{2}$; Eastern Extension, Australasian and China, Limited, $6\frac{7}{8}$-$7\frac{1}{8}$; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; German Union Telegraph and Trust, $7\frac{3}{8}$-$8\frac{1}{4}$; Globe Telegraph and Trust, Limited, $4\frac{3}{4}$-5; Globe, 6 per cent. Preference, $10\frac{1}{8}$-$10\frac{3}{8}$; Great Northern, $7\frac{3}{4}$-8; Indo-European, Limited, 19-20; Mediterranean Extension, Limited, $2\frac{1}{2}$-3; Mediterranean Extension, 8 per cent. Preference, $9\frac{1}{2}$-10; Reuter's, Limited, 10-11; Submarine, 215-220; Submarine Scrip, 2-$2\frac{1}{4}$; West India and Panama, Limited, $1\frac{7}{8}$-$2\frac{1}{8}$; Ditto, 6 per cent. First Preference, 8-$8\frac{1}{4}$; Ditto, ditto, Second Preference, $8\frac{1}{4}$-$8\frac{3}{4}$; Western and Brazilian, Limited, $2\frac{3}{4}$-3; Ditto, 6 per cent. Debentures "A," 85-90, Ditto, ditto, ditto, "B," 86-89; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds; 114-118; Ditto, 6 per cent. Sterling Bonds, 101-103; Telegraph Construction and Maintenance, Limited, 29-$29\frac{1}{2}$; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, $2\frac{5}{8}$-$2\frac{3}{4}$; India Rubber Co., $29\frac{1}{2}$-$30\frac{1}{2}$.

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PROFESSOR D. E. HUGHES.

DAVID EDWIN HUGHES was born in London in 1831. His parents came from Balla, at the foot of Snowdon, in North Wales, and in 1838, when David was seven years old, his father, taking with him his family, emigrated to the United States, and became a planter in Virginia. The elder Mr. Hughes and his children seem to have inherited the Welsh musical gift, for they were all accomplished musicians. While a mere child, David could improvise tunes in a remarkable manner, and when he grew up this talent attracted the notice of Herr Hast, an eminent German pianist in America, who procured for him the professorship of music in the College of Bardstown, Kentucky. Mr. Hughes entered upon his academical career at Bardstown in 1850, when he was nineteen years of age. Although very fond of music and endowed by nature with exceptional powers for its cultivation, Professor Hughes had, in addition, an inborn liking and

fitness for physical science and mechanical invention. This duality of taste and genius may seem at first sight strange; but experience shows that there are many men of science and inventors who are also votaries of music and art. The source of this apparent anomaly is to be found in the imagination, which is the fountain-head of all kinds of creation.

Professor Hughes now taught music by day for his livelihood, and studied science at night for his recreation, thus reversing the usual order of things. The college authorities, knowing his proficiency in the subject, also offered him the Chair of Natural Philosophy which became vacant; and he united the two seemingly incongruous professorships of music and physics in himself. He had long cherished the idea of inventing a new telegraph, and especially one which should print the message in Roman characters as it is received. So it happened that one evening while he was in the glow and enthusiasm of musical improvisation, the solution of the problem flashed into his ken. His music and his science had met at this nodal point.

All his spare time was thenceforth devoted to the development of his design and the construction of a practical type-printer. And as the work grew upon him he became more and more engrossed with it, until his nights were almost entirely given to experiment. He begrudged the time which had to be given to teaching his classes; and the fatigue was telling upon his health, so in 1853 he removed to Bowlingreen, in Warren Co., Kentucky, and acquired more freedom by taking pupils.

The main principle of his type-printer was the printing of each letter by a single current; the Morse instrument, the only other rival then in the field in America, required, on the other hand, an average of three currents for each signal. In order to carry out this principle it was necessary that the sending and receiving apparatus should keep in strict time with each other, or be synchronous in action; and to effect this was the prime difficulty which Prof. Hughes had to overcome in his work. In estimating the Hughes' Type-Printer as an invention we should never forget the state of science in those days, a quarter of a century ago. He had to find his own governors for the synchronous mechanism, and here his knowledge of acoustics helped him. Centrifugal governors and pendulums would not do, and he tried vibrators, such as piano-strings and tuning-forks. He at last found what he wanted in two darning needles borrowed from an old lady in the house where he lived. These steel rods fixed at one end vibrated with equal periods, and could be utilised in such a way that the printing wheel could be corrected into absolute synchronism by each signal current.

In 1854, Prof. Hughes went to Louisville to superintend the making of his first instrument; but the first patent for it was not taken out in the United States until 1855. In that form straight vibrators were used as governors, and a separate train of wheelwork was employed in correcting: but in later forms the spiral governor was adopted, and the printing and correcting is now done by the same action. In 1855, the invention may be said to have become a practical success, and no sooner was this the case, than Prof. Hughes received a telegram from the editors of the American Associated Press, summoning him to New York. The American Telegraph Company, then the leading one, was in possession of the Morse instrument, and levied rates for transmission of news which the editors could no longer stand. They therefore took up the Hughes instrument in opposition to the Morse. A company was formed, and the lines of the smaller fry of companies—among which was the Western Union Company, then doing business on a poor scale out West—were leased. After a time, they united in 1857 with these smaller companies to form one large corporation, the Western Union Telegraph Company of to-day. They bought over the Morse instrument too, and when the monopoly was all in their hands, the editors were again left in the lurch.

In 1857, Prof. Hughes, leaving his instrument in the hands of the Western Union Telegraph Company, came to England to effect its introduction here. He endeavoured to get the then Electric Telegraph Company to adopt it, but after two years of indecision on their part, he went over to France in 1860, where he met with a more encouraging reception. The French Government Telegraph Administration became at once interested in the new receiver, and a commission of eminent electricians, consisting of Du Moncel, Blavier, Froment, Gaugain, and other practical and theoretical specialists, was appointed to decide on its merits. The first trial of the type-printer took place on the Paris to Lyons circuit, and there is a little anecdote connected with it which is worthy of being told. The instrument was started, and for a while worked as well as could be desired; but suddenly it came to a stop, and to the utter discomfiture of the inventor he could neither find out what was wrong, nor get the printer to go again. In the midst of his confusion, it seemed like satire to him to hear the commissioners say, as they smiled all round, and bowed themselves gracefully off, "*Tres-bien, Monsieur Hughes—tres-bien. Je vous felicite.*" But the matter was explained next morning, when Prof. Hughes learned that the transmitting clerk at Lyons had been purposely instructed to earth the line at the time in question, to test whether there was no deception in the trial, a proceeding which would have been strange, had not the occurrence of a sham trial some months previous rendered it a prudent course. The result of this trial was that the French Government agreed to give the printer a year of practical work on the French lines, and if found satisfactory, it was to be finally adopted. Daily reports were furnished of its behaviour during that time, and at the expiration of the term it was adopted, and Prof. Hughes was constituted by Napoleon III. a Chevalier of the Legion of Honour.

The patronage of France paved the type-printer's progress into almost all other European countries; and the French agreement with Prof. Hughes. respecting it became the model of those of other nations. On settling with France in 1862, Prof. Hughes went to Italy. Here a commission was likewise appointed, and a period of probation—only six months—was settled, before the instrument was taken over. From Italy Prof. Hughes received the Order of St. Maurice and St. Lazare.

In 1863, the United Kingdom Telegraph Co., England, introduced the type-printer in their system.

In 1865, Prof. Hughes proceeded to Russia, and

in that country his invention was adopted after six months' trial on the St. Petersburg to Moscow circuit. At St. Petersburg he had the honour of being a guest of the Emperor's in the summer palace, Czrarskoizelo, the Versailles of Russia, where he was requested to explain his invention, and also to give a lecture on electricity to the Czar and his court. He was there created a Commander of the Order of St. Anne.

In 1865, Professor Hughes also went to Berlin and introduced his apparatus on the Prussian lines. In 1867, he went on a similar mission to Austria, where he received the Order of the Iron Crown; and to Turkey, where the then Sultan bestowed on him the Grand Cross of the Medjidie. In this year, too, he was awarded at the Paris Exhibition of 1867, a grand *hors ligne* gold medal, one out of ten supreme honours designed to mark the very highest achievements. On this occasion, also, another of these special medals was bestowed on Cyrus Field and the Atlantic Telegraph Company. In 1868, he introduced it into Holland; and in 1869, into Bavaria and Wurtemburg, where he obtained the noble Order of St. Michael. In 1870, he also installed it in Switzerland and Belgium.

Coming back to England, the Submarine Telegraph Company adopted the type-printer in 1872, when they had only two instruments at work. They have now (1878) twenty of them in constant use, of which number nine are working direct between London and Paris, one between London and Berlin, one between London and Cologne, one between London and Antwerp, and one between London and Brussels. All the continental news for the *Times* and the *Daily Telegraph*, is received by the Hughes type-printer, and is set in type by a type-setting machine in the very act of arriving. Further, by the International Telegraph Congress it was settled that for all international telegrams only the Hughes instrument and the Morse were to be employed.

In 1875, Professor Hughes introduced the type-printer into Spain, where he was made a Commander of the Royal and Distinguished Order of Carlos III. In every country which it was taken to, the merits of the instrument were recognised, and Professor Hughes has none but pleasant souvenirs of his visits abroad.

During all these years, the inventor was not idle. He was constantly improving his invention; and in addition to that he had to act as an instructor wherever he went, and give courses of lectures explaining the principles and practice of his apparatus to the various *employés* into whose hands it was to be consigned.

What with this work, and his various journeys, Professor Hughes can have had little time for original work in other directions. But very soon after the type-printer was finally off his hands, his attention was drawn to the telephone. The researches of Sir William Thomson on the variation of electric resistance in a wire subject to stress, led him to enquire whether or not sonorous waves could not be made to vary the resistance of the wire itself of the telephone circuit by stressing it, and the result of his discovery was, as everyone knows, the microphone. The Hughes type-printer was a great mechanical invention, the greatest in telegraphic science, for every organ of it was new and had to be first fashioned out of chaos; an invention which stamped its author's name indelibly into the history of telegraphy, and procured for him a special fame; while the microphone is a discovery which places it on the roll of investigators, and at the same time brings it to the knowledge of the people. Two such achievements might well satisfy any scientific ambition. Professor Hughes has had a most successful career; and probably no inventor ever before received so many honours, or bore them with greater modesty.

THE SOURCE OF SOUND IN THE TELEPHONE.

An Experimental Investigation by Aid of the Microphone.

By Prof. D. E. HUGHES.

A recent discussion upon the theory of the telephone* has caused me to make a series of experiments to determine if the sounds in that instrument were produced by the molecular action described by De la Rive, Page, Wertheim, and others, where sounds were heard in wires and electro-magnets upon the passage of a strong intermittent current through them; or if simple electro-magnetic attractions and repulsions were sufficient to fully account for all the phenomena of the telephone.

From a few experiments made some time since without any diaphragm and in which sounds and speech were perfectly reproduced, I was inclined to believe that we must look to the molecular action as playing a very important part, but on submitting each part of the telephone to experimental investigation by aid of the microphone, I have been led to believe that the molecular action is so feeble compared with the electro-magnetic attractions and repulsions, that its action has really no important *rôle* where we deal with such feeble currents as are generally produced in the telephone.

In order that the telephonic effects should be strongly marked and at the same time too weak to produce any molecular sounds, three elements of Daniell's battery were employed. These gave me telephone sounds sufficient to be heard at a distance of two or three feet, but at the same time, on submitting each part to the microphone so that it should take up only those sounds due to the organ submitted to its examination, no sounds were heard that could be fairly attributed to molecular action, whilst the effects due to known electro-magnetic action were extremely marked and distinct.

The microphones, which were vertical ones, were arranged in two distinct circuits, the first being used as a transmitter of undulatory currents to the telephone coil which was under investigation, the second microphone was attached to a small board 6 inches square and insulated by india-rubber feet, and wires were led from this microphone through a battery to a telephone; the batteries in each circuit was

* Comte du Moncel and Col. Navez. See Telegraphic Journal, Sept. 1, 1878.

three Daniell's elements. The transmitting microphone was placed in a distant room and the source of sound generally used was an ordinary French *reveil* clock, this giving the maximum of sound obtainable without interruptions of circuit. In many cases the results were verified by transmitting speech; but I had long before found that whenever the peculiar timbre of the clock could be heard, articulate sounds were also perfectly reproduced.

By this arrangement, the microphone being so adjusted that it was only sensible to sounds mechanically transmitted to it through the board, whilst insensible to sonorous waves transmitted through the atmosphere, each organ of the telephone could be investigated separately by putting that piece alone in contact with the microphone table, whilst the other organs were held at certain distances in the air.

The following is a sketch of this arrangement:—

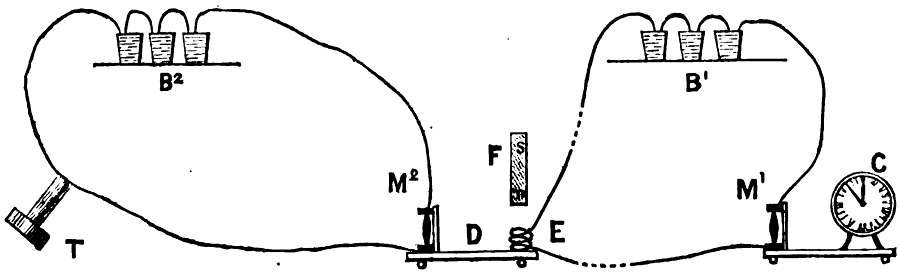


FIG. 1.

were heard if the battery was increased to twenty elements. Different coils of size, shape, and number of wire were tried, but no sounds were audible on any. On now approaching a strong bar magnet (6 × 1 inch) near to the coil, say ¼ inch distant, I at once hear the sound with all its peculiar timbre, the sounds increasing or decreasing as I put the magnet nearer or farther from the coil. The sounds, however, at their maximum, were but one-fortieth (approximately) of ordinary telephonic ones.

It is here evident that the sound is due to the mutual action between the current in the coil and the strong magnetic field, in other words to that electro-magnetic action which tends to cause a current in a wire crossing the lines of force in a magnetic field to move in a direction perpendicular to itself and to the lines of force which it crosses.

1st, or transmitting circuit:—C, clock, or source of sound; B¹, battery; E, coil, resting on sound microphone table; M¹, microphone transmitting electrical variations of current produced by clock C; F, natural magnet, held at certain distances but insulated by air from mechanical contact.

2nd, circuit upon which sounds produced upon the table were augmented by the microphone and transmitted to the receiving telephone; M², microphone; B², battery; T, receiving telephone, or microphone receiver.

This arrangement was used throughout the following microphonic experiments, and as we have now only to change the coil E, or affix to the table D any part under investigation, we shall in future refer only to the table D.

I will now speak of the experiments, which have all been reproduced several times at distant intervals, and on describing each, I will give the reasons for its result as they appear to me.

COILS.—Experiment I.—The ordinary coil of a telephone being placed on the table gave out no appreciable sounds. (I may here remark that, when I say no sounds, I merely state that with the feeble undulatory currents employed, no sounds were heard, although this same current was sufficient to produce exceedingly loud tones when all the organs of the telephone were put together and properly adjusted.) In the above case feeble sounds

II.—A coil of fine iron (covered) wire (No. 30) gave out at first no sounds, but gradually became audible as the wire itself became magnetised by the current. If the bar magnet was brought near, the sounds were much louder than the copper coil, being about $\frac{1}{30}$ of telephonic ones. The magnetic field is here increased by the wire itself being a magnet.

III.—Two coils of copper wire of similar length but of different shape; the one being 2 inches in height by 1 inch diameter, the other a flat coil of 2 inches diameter by ½-inch; each being tried separately it was found when the pole of the magnet was held near their centres that the flat coil gave out double the sound of the other, but if held near the sides, the reverse effects took place.

(The larger surface of the flat coil explains the increased sound when a magnet is held over its centre, but in the second case the longer surface of the 2 inch helix explains its increased action.)

IV.—The coil resting upon table giving out clear sounds when the magnet was near, the magnet was replaced by the coil of an electro-magnet without its iron core. With a strong local battery passing through this coil similar effects to those of the magnet were obtained, though not so strong, owing to the difficulty of inducing so strong a magnetic field as the magnet alone; but on introducing its

iron core the sounds became as loud or louder in proportion to the strength of the field of force.

V.—If a flat magnet was laid on the table and the coil held at a distance, the sounds were louder and more metallic than in the cases when the coils were placed on the table. If the magnet was inside the coil and also resting on the table, the sounds were not nearly so loud as when the coil rested simply beside the magnet.

(In this case if the coil was absolutely fixed upon the magnet and no movement possible of the copper wire, we should only have the sounds due to the magnet and coil reacting upon the earth's magnetic field, and I found that if the coil was loose, much louder sounds were obtained than when it was fixed; but when it was placed flat on the side of magnet the full electro-magnetic reactions of coil on magnet were observed, consequently the sounds proved to be much louder than when the magnet was placed in the centre of the coil.)

VI.—If instead of the bar-magnet both poles of a horse-shoe magnet were introduced, the sounds were still heard, but far more marked when the coil lies on the sides of the horse-shoe. In this experiment the north and south pole, both being in the same coil, it would be natural to believe that one should neutralise the effect of the other, and I originally held this to be an argument in favour of the molecular theory; but we shall see in experiments under the head of "pendulum" that it is fully explained by the greater effect of the magnetic attractions than the repulsions.

VII.—If on one end of the bar magnet with its coil a microphone was attached so as to be influenced only by its elongation, no sounds whatever were heard—although it was sensitive to a hair lightly drawn across the pole. No trace of sound whatever could be heard; thus, if the sound was due to molecular changes, we should have certainly expected to have heard slight sounds at least from an undulatory current which was producing sufficient electro-magnetic changes to give out the loud tones upon the diaphragm, as already mentioned.

VIII.—If upon the microphone table I strained a wire 6 inches long, similar to a musical string, and through this wire pass the current, I heard no sounds; but on putting a strong horse-shoe magnet so that the wire was between the poles (which in this case should not be apart more than ½ inch), I heard very plainly, and remarkably so, when we consider that in the case above mentioned, there were but a few inches of the wire under the influence of the magnetic field. Sounds were thus obtained from a wire only one centimetre long on the board; fine iron wire gave out the loudest effect, but this was found to be due simply to its becoming magnetised and thus reacting more strongly on the field of force.

(In all the above experiments the sound obtained was not at its maximum more than one-twentieth of telephonic ones, so we cannot consider any of these points as predominant sources of sound.)

IX.—Armatures or Diaphragms.—An iron armature, no matter what form or size, when placed upon the microphone table gives out loud tones, the magnet and coil being held in the air and thus insulated; the loud tónes can only be due to the armature in contact with the table.

(The sounds here are due to magnetic attractions, the loudness depending upon the best conditions for movement and rapid action in a strong magnetic field. In some following experiments this point will be elucidated.)

X.—If a copper coil without the magnet, is held above these armatures, the sound is comparatively weak. An iron coil gives louder tones, due to its becoming magnetised, but both are very weak compared with those given by the side of the natural magnet. An electro magnet with iron cores was not equal to the natural magnet, because the battery was too weak to induce a high magnetic field.

XI.—With different metals and non-conductors, such as wood, glass, gutta-percha, ivory, metallic oxides, &c., &c., it was found that all conductors, if sonorous, gave out sound; but no continued trace could be found with mercury, and but slight traces with lead. All the non-conductors gave no sound whatever.

Compared with iron the following is an approximate value, being the mean of several repeated experiments:—

Iron	100
Silver	10
Copper	9
Bronze	9
Zinc	8
Gold	8
Brass	7
Cadmium	6
Tin	4
Lead	2
Carbon	2
Mercury	1
Wood, Glass, and all non-conductors	0

(All the above non-magnetic conductors gave out sound by direct mechanical movement, caused by the induced currents re-acting upon the magnetic field, giving repulsions where iron was attracted. This will be shown in some following experiments.)

XII.—With all the non-magnetic metals, the sound was loudest if the armature had a large surface, as a plate or sheet; the sounds were at their maximum when the magnet and coil were held over the centre of the plate, and gradually diminished when moved towards the edges.

(This shows the importance of the diaphragm form of armature, and in the case of copper, the induced currents had a wider field for action when the magnet was held at the centre than when at its edges.)

XIII.—Each metal gave out its own particular timbre, which could be perfectly reproduced by touching it with a small strip of thin paper at the point where the centre of the magnet had been held.

(This shows that the supposed molecular sounds were really mechanical movements which could be reproduced by a feeble mechanical effort.)

XIV.—A coil of insulated copper wire placed on the table as an armature, gave but feeble traces of sound if the two ends of the wires were insulated, but on joining the wire or short circuiting the coils, loud and distinct tones were always obtained.

(This proves that the sounds are due to the re-action of induced currents in the coil upon the magnetic field.)

XV.—A coil of uncovered copper wire gave out sounds if the ends were open or closed, being then similar to a copper plate, where the currents can flow in closed circuits.

XVI.—A flat magnet gives out louder tones than an iron armature of the same form, and a still more remarkable difference is observed if a coil alone without its magnet is held above. In this case, the magnetic armature gives out tones ten times stronger than the simple iron, thus showing again the necessity for a strong magnetic field of action.

XVII.—A coil of covered iron wire gives out the same amount of sound whether the circuit be closed or open.

XVIII.—A thin iron plate armature gave out loud and clear tones; these tones were but slightly diminished by the interposition of another thin plate or plates, of iron, between the magnet and coil and armature. Sounds were thus obtained through fifteen interposed iron diaphragms, being then but a quarter of the original sound. If, however, the sum total of all the diaphragms could have been utilised, the total sound would have been greatly augmented.

XIX.—The coil of covered copper wire was laid on the top of a ferrotype iron plate; the natural magnet alone held above this, gave out strong tones, but if the coil was placed underneath the ferrotype, the sounds were but one-third of its previous force; this shows the advantage of having the coil direct in the magnetic field, between the magnet and its armature. In both cases, sounds were scarcely audible when the natural magnet was withdrawn: they were not one-twentieth of the original sound intensity.

(From this we cannot expect any perfect electromagnetic telephonic arrangement which does not employ a strong magnetic field for its reactions.)

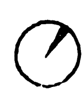
XX.—If we place on the microphone table a solid cube of iron (2 inch cube), the coil and magnet being held at a slight distance, we hear distinctly the tones, but far more feeble than in the case of a thin ferrotype of the same diameter. With the ferrotype we hear a clear metallic ring with each tone, but with the cube of iron there was no such ring, the tone being dull and muffled; in fact, the tones were those of the microphone table itself, thus indicating that the slight mechanical movement of the iron cube was transmitted to the wood, which, by it elasticity, became in reality the diaphragm or source of sound. To prove this, we found that sounds increased up to the moment when the natural magnet touched the iron, when they attained their maximum. On pressing the magnet on the iron with gradually increasing pressure, the sounds gradually faded until but slight traces were audible. On removing the pressure, sounds increased until the magnet raised the iron slightly: here was the maximum; but the instant the iron by its own weight broke the contact and thus again pressed more heavily on table, the sounds almost disappeared. Compared with the ferrotype, it was found that the latter gave out louder tones with the magnet and coil held at 3 inches distance, than upon the cube of iron at $\frac{1}{16}$ inch distance. At $\frac{1}{4}$ inch distance but feeble traces of sound could be heard in the cube, whilst the ferrotype gave out loud tones with its own peculiar metallic ring. In both cases the peculiar timbre of the cube and the ferrotype could be reproduced by touching it lightly with a thin strip of paper; thus, a slight mechanical movement would easily account for the sounds in both cases.

XXI.—A ferrotype diaphragm laid loosely on microphone table. Magnet and coil held above gave out with each sound a metallic ring exactly the same as when the same diaphragm was held to the ear and slightly touched by a piece of paper. If it was fastened on the table by its circumference, as in the telephone, we had one dominant musical note with each sound. If fastened only at its centre, the metallic ring would be prolonged long after electromagnetic sounds had ceased, it being then in a constant state of vibration from the slightest extraneous cause. If we glued or fastened this diaphragm to a thin cardboard, the metallic ring disappeared, and the tone became slightly weaker and muffled. If the diaphragm was glued throughout its surface to a similar piece of pine board 1 inch thick, the tones became very weak, resembling the cube of iron, and the tone was no longer that of iron, but that of wood.

(This shows that the tones could not be due to any particular molecular movement in the iron plate, but that the tone or timbre is due to the body actually in movement, as the metallic tones of iron can be gradually masked, partaking of the intermediate tones of iron and wood, until, by increasing the thickness of wood, the metallic tones are entirely lost by the predominance of those of the wood.)

XXII.—The surface of a diaphragm of cardboard had glued to it parallel layers of thin uncovered iron wire; this diaphragm gave out the tones of cardboard either on the microphone table or if it replaced the ferrotype in an actual telephone; in both cases the tone was comparatively weak, compared with the same amount of iron and surface in the ferrotype, a result due to the want of elasticity in the cardboard. The same iron wire glued to a thin glass plate gave out clear, sharp tones, but the tone was that of glass, and not that of iron. From this we should judge that the varnish on ferrotype serves an excellent purpose in slightly muffling the metallic ring of the iron plate.

XXIII.—In order to see if we could render these movements of the diaphragm visible to the eye or touch, a thick tin plate diaphragm was placed in a telephone in direct circuit of the first transmitting microphonic circuit. The sounds were very clear and loud, but no movement whatever of the diaphragm could be perceived by the eye or touch. A very thin charcoal iron plate was now used; the tones were louder than before, but still no visible movement. This plate then had a small narrow segment cut out of it from the circumference to the centre.

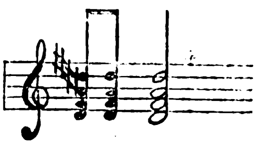


The sound was slightly diminished, but strong movements were visible both to eye and touch; by placing the finger on the divided portion not only could every beat of the clock be perfectly felt, but its peculiar timbre in a slight degree recognised.

(Here we have transformed a sound which in the first place gave out no visible movement, and which might from this be supposed to be due to some molecular motions, into one of direct mechanical movement recognisable by touch, and where molecular action is not at all necessary to its explanation.)

XXIV.—Knowing that each diaphragm in a telephone has its own dominant tone, which accompanies all sounds emitted, the diaphragm was divided into two slightly unequal portions. Clear loud tones were then produced as before, but they were accompanied with two dominant tones—in fact, a chord, due to the different dominant tones of each segment of diaphragm. By chance they happened to be an exact fifth, and the word "telephone," like all other words transmitted to it, was accompanied by the dominant chord, thus:

and I am convinced that by proper arrangements four segments reproducing the whole cord could have been obtained, thus:



(To be continued.)

THE WERDERMANN ELECTRIC LIGHT.

The most recent development of the electric lighting system is that invented by Mr. Richard Werdermann, and which was shown on Saturday, November 2nd, at the works of the British Telegraph Manufactory, 374, Euston Road, to a number of scientific gentlemen and representatives of the press.

Mr. Werdermann was assisted in his experiments by Mr. Berger Spence and Dr. Cornelius Herz. The chief object of the inventor was to demonstrate that by the new system a considerable number of lights could be placed in one circuit and steadily maintained without the employment of any clockwork or electro-magnetic apparatus connected to the lamps.

The display was chiefly of an experimental character, the lamps used being somewhat different in construction to those which will be placed in actual work, but it was quite sufficient for scientific purposes.

The principle of Mr. Werdermann's invention, consists in keeping a small vertical pencil of carbon in contact with a large horizontal disc of the same material above it. Mr. Werdermann was led to adopt this arrangement as the result of numerous experiments.

Referring to fig. 1, which shows the ordinary arrangement of carbons in an electric lamp, it is well known that when the passage of the current is such that the top carbon is a positive pole, the end of this carbon becomes cup-shaped, whilst the end of the other carbon becomes pointed, by the action of the current. By increasing the lower carbon considerably in sectional area, Mr. Werdermann found that, with the same amount of current passing, it was necessary in order to maintain the continuity of the arc, to place the two carbons closer together; he also noticed (as a curious fact) that a little cylindrical pimple of carbon was formed in the middle of the lower carbon electrode, as shown by the figure; also the end of the upper carbon tended to spread out. On still further increasing the size of the lower electrode, it was found necessary to bring the two carbons still closer together in order to maintain the continuity of the arc; the little cylindrical pimple then became much smaller in size, and the end of the upper carbon spread out still more. If now, the lower carbon was still further enlarged, so that it had a sectional area sixty-four times as large as that of the upper carbon, it was found that the continuity of the circuit could only be maintained by keeping the two carbons in actual contact; and further, it was observed, that the end of the upper carbon, which had previously tended to spread out, now took a pointed form. When actual contact took place the little pimple of carbon disappeared, and a brilliant light was given out by the incandescent point.

Figs. 5, 6, and 7 show what occurred when the larger carbon formed the positive pole. Under these conditions the end of the small electrode became heated to a red heat only, whilst a small portion only of the large electrode became heated to a white heat by the passage of the current; this was also the case when the upper electrode was increased in size, and the two carbons had to be approached closer together in order to maintain the arc. When, however, the upper carbon was increased to such a size that continuity could only be maintained by actual contact, then a curious change took place: the upper carbon no longer glowed, but the point of the smaller carbon, previously only red-hot, now became white-hot, and assumed the conditions shown by fig. 4. The light given out when the larger carbon formed the positive pole was found to be not quite so great as when it formed the negative pole. The heat being almost entirely confined to the smaller carbon, the larger one was not consumed to any appreciable extent.

During the whole time that the smaller carbon burns, it retains its pointed form, and a small electric arc is plainly visible round the points of contact of the two carbons. The greater part of the light given out is produced by this small arc.

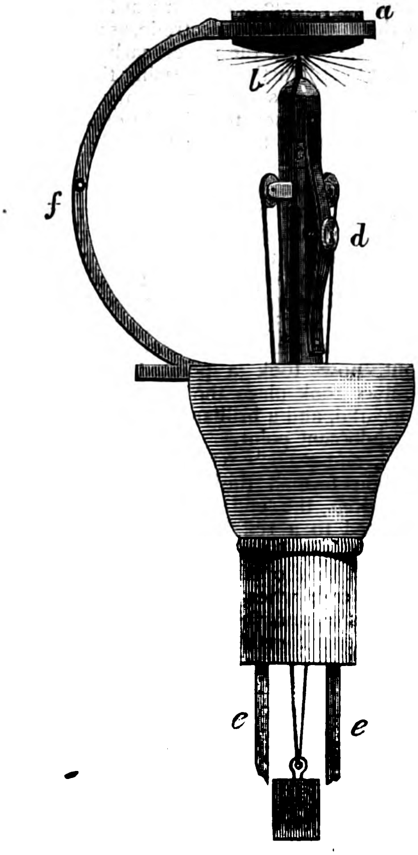
In accordance with the foregoing results Mr. Werdermann constructs his lamps in the following manner:—

He places the negative electrode uppermost, giving it the form of a solid disc of carbon, about two inches in diameter and one inch thick. This is encircled by a band of copper ribbon and prolonged to a terminal to which one of the machine wires is attached. The lower or positive carbon, which is a

thin round pencil, 3 millimetres in diameter, is placed vertically beneath the negative electrode, in a tube up which it slides. This tube has a prolongation of thick copper divided in two parts, and pressing against the pencil and forming contact with it, this forms the other terminal of the lamp.

The lower carbon is kept in contact with the upper one by chains attached to its lower extremity, coming up over pulleys and down again to a counterbalance weight, which always keeps the point of the pencil in gentle contact with the disc as the former gradually burns away.

Fig. 1a.



By referring to the sketch, fig. 1a, the general idea of the lamp will be seen at a glance.

"*a*" is the negative carbon, *b* is the pencil sliding in the tube *c*, and gripped at the top of the tube by the split contact piece, the pressure of which is regulated by the spring *d*. The conductors *e* form part of the lamp post, having terminals at the bottom, and one is connected to the tube, the other, by means of the semicircular piece of metal *f*, to the upper carbon; *f* is hinged for the purpose of moving away the negative disc when a globe is to be put on the lamp.

The tube is shown in perspective for the sake of greater clearness.

The experiments were commenced by putting two tall lamps in circuit such as will be used for out-door lighting.

These lamps gave a light estimated at 360 candles each, and were connected together in parallel circuit. The lamps had no globes, and the lights were wonderfully clear, of a pure colour, and perfectly free from the blue or purple rays so often seen in the electric arc. Better than all was the remarkable steadiness of burning, there being an entire absence of any jumping or flickering whatever.

After allowing these to burn for some time, the current was then sent through a row of 10 smaller lamps, arranged on a shelf, and connected parallel. These lamps were estimated to give about 40 candles each, each one burned with the same brilliancy and steadiness, and proved most conclusively that the divisibility of the light was an accomplished fact, and when we say that this satisfactory result was obtained with an electro-plating Gramme, the bobbins of which are wound with thick copper ribbon, and giving an electro-motive force of only 4 Daniell's cells, it seems probable and reasonable to suppose that with suitable machines, Mr. Werdermann will be enabled to put 50, 100, or even 500 lights in circuit, and thus solve the problem of dividing the light more completely than has hitherto been the case.

In fact, Mr. Werdermann stated that had his lamps been ready he could have put in circuit a considerably greater number of lights than were exhibited.

Fig. 2a shows the connections of the 10 lamps.

The thick wires + and — are the cables connecting the lamps with the Gramme machine, the first lamp on the pos. being the last on the neg. The spirals "*a*" are equal resistances placed in the circuit of each lamp for the purpose of rendering any variation in the contact or pressure of the two carbons less appreciable to the passage of the divided currents.

The resistance on the average of each small lamp including the extra resistance "*a*" is 0·392 ohms.

5 lights parallel ... „ 0·076 ohms.
10 lights, do., as exhibited „ 0·037 ohms.

The resistance of the large lamps is rather less than that of the small ones.

In the 10 small lamps the carbon pencils burn away at the rate of about 2 inches per hour.

The large lamps having pencils of 4½ mm. diameter, burn from 2½ to 3 in. per hour.

The carbons are manufactured in Paris in lengths of about one yard, and at a cost of about 1 franc per yard, which length would keep up a light for 12 hours.

The negative discs are of ordinary battery carbon, and the weight required to keep carbons in contact is about 1½ lbs.

The length of carbon protruding from the tube and made incandescent is ¾ of an inch, but this length can be varied at pleasure. However many lights may be put in circuit the extinction of one or more will not affect the rest, a switch arrangement attached to each lamp effecting all that is required for the regulation of the current.

Then again, by this system, all the lamps are lighted simultaneously, and can all be as readily extinguished, and again re-lighted.

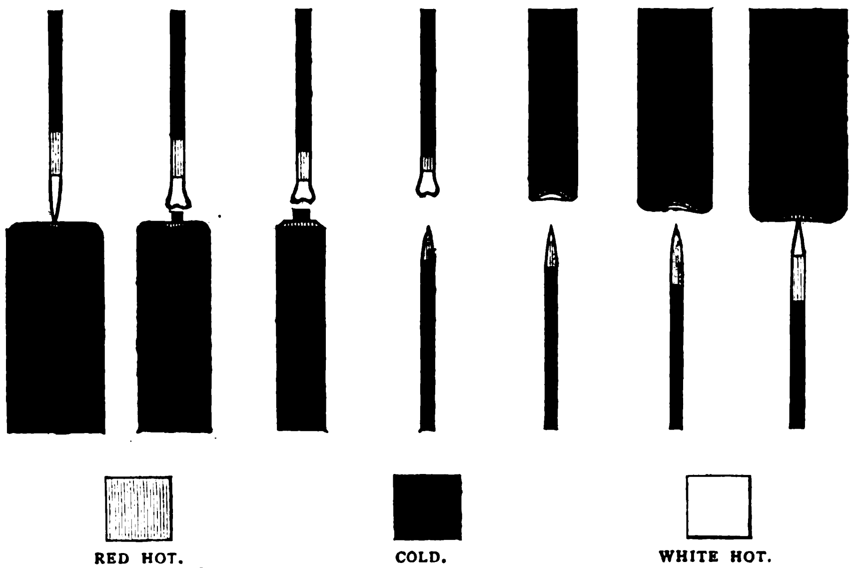
In regard to the strength of this light, we have before observed that one object of the inventor is to moderate the intensity, so as to avoid having any of the illuminating power reduced by covering the

lamps with opal or ground glass globes, as in other systems. The two large lamps did not dazzle the eyes, there being no change of colour and no jumping, so it is therefore the intention of Mr. Werdermann to use ordinary glass globes, so that scarcely any loss of light will be incurred.

To some questions put to him by a gas engineer, Mr. Werdermann aptly compared the quantity of current with the quantity of a gas-holder, and the

It may be mentioned that Mr. Werdermann does not believe in the divisibility of the current *ad infinitum*, as claimed by Mr. Edison, but that for practical purposes he has every confidence that the system we have described will solve the problem of general electric lighting, and that he will be able to carry the current to a considerable distance. Mr. Werdermann has already had numerous applications for the installation of his system.

Figs 4 3 2 1 5 6 7



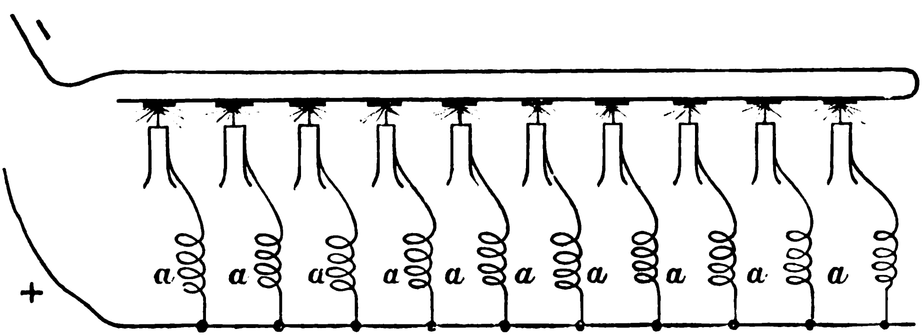


Fig. 2A.

electro-motive force of the current to the pressure of gas.

For instance, if a gas-holder held sufficient gas, and had enough pressure to supply 100 burners, it would be necessary to increase the quantity and pressure of the gas to equally light 200 jets. It is the same with the electric light. If with one machine of given quantity and electro-motive force, 100 lights can be produced, then if 200 lights are required we must have a machine with a greater quantity of current (corresponding to the capacity of the gas-holder), and with greater electro-motive force to carry the lights further away (answering to the pressure of gas).

In conclusion we give some details of the machine by which the lights were produced. It is of the old form of Gramme electro-plating machine, with four upright electro-magnets, and two bobbins revolving between them. The bobbins are iron rings wound each with 48 sections of copper ribbon seven-sixteenths of an inch wide, and one-tenth of an inch thick. Each section has three convolutions. One bobbin is used for magnetising, or feeding the electro-magnets, the other for producing the working current. The resistance of this latter bobbin is about 0·008 ohms, and the electro-motive force, as before mentioned, is only four Daniell's cells, the machine being driven at a rate of about 800 revo-

lutions per minute. The quantity of current produced is of course large; but as the intensity is very low, it follows that the insulation of the conducting cables could easily and cheaply be provided for.

The heating of the machine after several hours continuous running was but very slight.

The power required to drive the machine is only two horse-power.

EDISON'S NEW MICRO-TASIMETER.

By W. F. BARRETT.

IN its present form the instrument differs considerably from that described in the TELEGRAPHIC JOURNAL of August 1st, although the essential parts are the same. The object of this modified arrangement is to insure greater sensibility and protection from accidental sources of disturbance. Sketches of the instrument are here given. The carbon button is laid flat within an insulating cup in the centre of a small but massive brass base A; resting on the button is a light metal disc which supports a slender strip of vulcanite, about an inch long and a quarter of an inch wide. Vulcanite is used on account of the comparatively large dilatation it

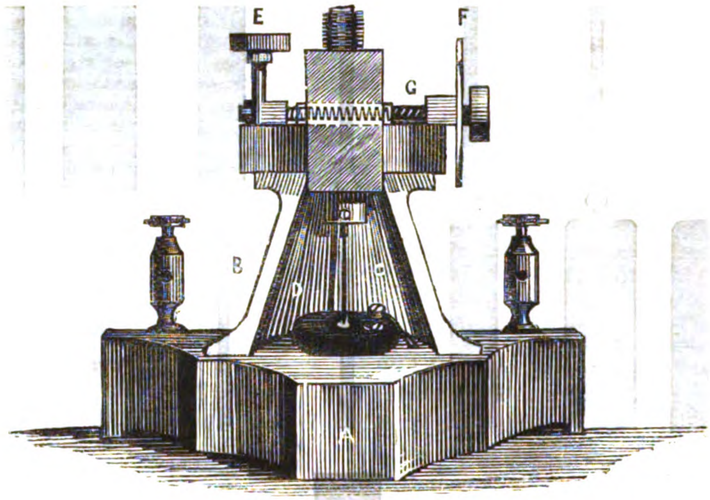


FIG. 1.—FRONT REMOVED.

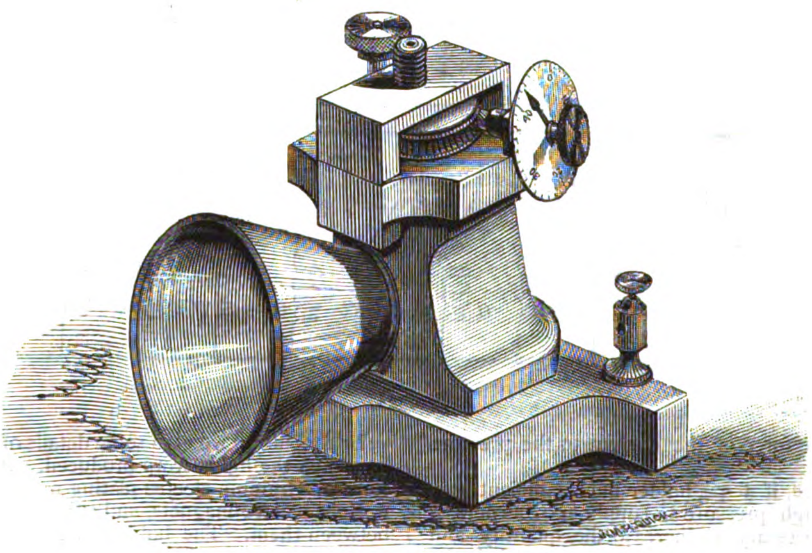


FIG. 2.—HALF NATURAL SIZE.

undergoes when warmed, but a strip of blackened zinc is more prompt in its indications. The upper end of the vulcanite strip abuts against the base of a vertical screw, capable of an extremely fine motion by means of a worm-head gearing into a tangent screw G. Attached to the milled head of the latter is a small pointer moving over a graduated circle F

Each division in this circle corresponds to a motion of the fifty-thousandth part of an inch imparted to the vulcanite strip, and thus a corresponding small degree of pressure can be brought to bear upon the carbon button below the strip. A polished cone converges radiation upon the vulcanite, which is enclosed in a metal casing except on the side opening to the cone. The upper and lower faces of the carbon button are in metallic communication with a cell or two of a constant voltaic battery and with a delicate reflecting galvanometer of low resistance. A Wheatstone's bridge and resistance coils are also included in the circuit to balance the resistance of the carbon; and at first a "shunt" of thick wire is necessary to deviate through itself the greater part of the current, and so curb the motions of the galvanometer needle. When the proper balance is obtained—the fine adjustment being made by turning the micrometer screw that presses the carbon—the shunt is removed and the tasimeter is ready for a test experiment.

The heat radiated from one finger held near the cone is more than sufficient to drive the galvanometer index right across and off the scale. In a letter relating to this tasimeter, Mr. Edison writes to me as follows:—"By holding a lighted cigar several feet away I have thrown the light right off the scale," and by increasing the delicacy of the galvanometer, "the tasimeter may be made so sensitive that the heat from your body, while standing 8 ft. from and in a line with the cone, will throw the light off the scale, and the radiation from a gas jet 100 ft. away gives a sensible deflection."

These statements—less extravagant than those that have appeared in some newspaper reports—are quite consistent with my experience of the instrument, and they show that the tasimeter is a marvellously delicate thermoscope, and as such, or as a means of detecting minute variations in pressure, it is a really valuable addition to the cabinet of the physicist. It is not, however, likely to displace the thermo-electric pile in experiments on radiant heat; albeit, when the small area on which the radiation falls in the tasimeter is taken into account, it is no doubt a more delicate thermoscope. In fine, owing to the narrow linear surface it exposes, the tasimeter will probably do good service in such researches as the distribution of heat in solar and other spectra, and in exploring the ultra-red portion of the solar spectrum. By an ingenious device, characteristic of the man, Mr. Edison has shown how the tasimeter may be used as an instrument for detecting the presence of moisture in the atmosphere. All that is necessary is to remove the vulcanite strip and replace it by a strip of gelatine varnished on the unexposed side, when it becomes an hygrometer of surpassing delicacy. Another application of the tasimeter, which, perhaps, Mr. Edison will allow me to suggest, is for detecting variations in the pressure of the atmosphere. As a new form of aneroid baroscope it would doubtless give extremely prompt and delicate indications, and thus be of considerable service to meteorologists. The application of the instrument for detecting minute changes in the length of a body is obvious, but before it can come into use in any quantitative experiments, further investigation is necessary, and several minor modifications of the present apparatus are requisite.

Notes.

THE TELEPHONE.—Mr. McLure, the manager of the Bell Telephone Company, London, has effected several convenient improvements in the Bell telephone and its fittings. To adapt the telephone for general household use Mr. McLure arranges an alarm bell, indicator, and commutator in the servants' hall, and a telephone in each room. When a person in one of the rooms wishes to communicate with the attendant he simply touches a spring in the stem of the telephone at his disposal: this rings the alarm bell and indicates the room from which the call has come to the attendant. The attendant, by setting the commutator to that room, re-sets the indicator to its zero position and puts his telephone in circuit with that in the room in question. Conversation can then be carried on between them. By this arrangement telephones can be supplied to every room in a house at as cheap a rate as electric bells, thus effecting a considerable saving of time and trouble. By a similar arrangement persons in different parts of a city can converse through the medium of a central station, in which the commutator is placed. Mr. McLure, among others, is now experimenting with a view to overcoming the induction clamour on telephone lines.

THE MICROPHONE.—On another page we publish an important investigation by Professor Hughes into the sources of sound in the telephone—a problem which has been rendered soluble by means of the microphone. The research in question is the continuation of some former experiments recorded in the *Telegraphic Journal* for September 1. Some of the facts demonstrated cannot fail to be useful in the improvement of telephones.

THE PHONOGRAPH.—The Stereoscopic Company are not yet prepared to supply phonographs to purchasers. The price to be put on them when they are offered for sale is, we believe, thirty guineas.

THE ELECTRIC LIGHT.—The details of Edison's new invention are still kept secret, and, as will be seen from our list, a second patent has been applied for. Meanwhile, the *Scientific American* professes to give the following partial information, which is a little more explicit than what was vouchsafed to us in our last issue:—"The Edison light," says our contemporary, "is based on the well known fact that a wire may be heated by an electric current, the basis of many attempts to accomplish what Mr. Edison claims to have done. The reader may have seen the gas jets of the dome of the Capitol at Washington, lighted by similar means. Over each burner is placed a coil of platinum wire, which, when heated by the electric current, ignites the gas. Mr. Edison uses the coil itself as the source of light, the current sent through it being strong enough to make the coil white hot, or self luminous. The difficulty to be overcome at this point was the liability of the wire to fuse and spoil the light; a difficulty which Mr. Edison claims to have obviated by the introduction of a simple device which, by the expansion of a small bar the instant the heat of the coil approaches the fusing point of platinum, interposes a check to the flow of the current through the coil. This automatic arrangement, in connection with an auxiliary resistance coil, secures, it is said, an even flow of electricity through the coil, and consequently a steady glow of pure light. If this is done economically it is obvious that a marked advance has been made in artificial illumination." It may be presumed that Mr. Edison

has more to reveal than what is given above, for although this device will undoubtedly facilitate the subdivision of the current for lighting purposes, it will not alone justify the inventor's claim.

A COMMISSION has been appointed to examine the question of illuminating the harbour of Cronstadt by the electric light, in order to prevent night attacks on the forts.

A MUNICIPAL council is also considering the advisability of lighting the streets of St. Petersburg by electricity.

ON Monday, November 4, a football match was played at Kennington Oval by Siemens' electric light, but it was only a partial success by reason of the operators not being able to direct the beam quickly enough upon the ball.

ARNAUD'S ELECTRIC LIGHT DIVIDER.—M. Arnaud explains that his system consists in inserting cross circuits between the outgoing and returning wires of the main circuit. These cross circuits contain the lamps, and a specially divided current, giving equal lights to all the lamps, is sent into this complete circuit.

THE electric light is being tested for use in the Royal Arsenal workshops and at the Woolwich laboratories. It will also be tried in the General Post Office, St. Martin's-le-Grand.

THE *American Journal of Gas Lighting* now triumphantly asks, How is the electric light to be measured and sold? Gas can be estimated both in quality and quantity; but electricity!—that is a very different affair. In another part of the same journal a second fatal objection is put forth—"the ladies dislike it." Can human gallantry resist this appeal?

EXTENSIVE additions begun at the Beckton Gas Works have been stopped pending the invasion of the electric light.

THE electric light is likely to reduce the price of coals considerably, since the gas companies will consume a greatly reduced quantity.

RAPIEFF'S ELECTRIC LIGHT.—M. Rapieff has further improved his electric light which we illustrated and described in our last issue, by substituting a single thick carbon for the two upper rods. This improvement would seem to approximate the light somewhat more to Werdermann's plan.

THE pre-announced trial of Jablochkoff's candle at Billingsgate Fish Market on Nov. 5, did not come off, but preparations are now being made for one on an early date. There will be sixteen 1,000 candle-lights reduced 60 per cent. by opal globes. Eight of these will illuminate the ground floor, an area of nearly 40,000 square feet. The whole building will be illuminated inside as well as the outside front.

REYNIER'S ELECTRIC LIGHT.—One of the successful competitors for electric light renown is E. Emile Reynier, a young Parisian student of science and electric mechanician. Reynier's lamp consists in a slender upright stick of carbon placed so that its point is tangential to the edge of a thick disc of carbon. The stick is fed by the positive current, and the disc by the negative, and as the point is in contact with the disc there is no voltaic arc to speak of, but merely incandescence of the carbon stick, which slowly burns away. To the disc is given a slow rotation and the ash of the carbon stick is thus cleared away. As the stick consumes it is forced downwards into contact with the edge of the disc by the descent of a heavy bar. From this description it will be seen that Reynier's *lampe electrique à incandescence*, as it is called, is somewhat similar to Mr. Werdermann's which we illustrate on another page; but it is clearly not the same. Werdermann's is a *lampe à incandescence;* but by a different arrangement of the carbons, he produces a finer and steadier light than Reynier, by means much simpler. Reynier's lamps are made by the Société des Lampes Electrique Française, 71, Rue de la Victoire, Paris. Price £5.

IT is said that a householder, whose gas had been suddenly cut off recently, brought matters right by sending a photograph of Edison to the gas company.

THE New York Board of Aldermen, on the 14th ult., granted permission to General Spinola to introduce the Holly Steam Heating system into that city. This system consists in distributing steam from central stations to streets and houses by means of pipes for heating purposes. Should the New York gas mains be rendered by Edison's invention no longer useful for gas they may do for the steam.

WHEN Edison brings that new electric light into use, the fellow who goes to a party with a patch on the knee of his pants must come out of that dark corner and be exposed.—*Detroit Free Press*, U.S.

THREE applications of the electric light are obviously practicable forthwith, and likely to be of great service, namely, lighting ships at sea, lighting railway trains, and lighting fields, so that harvest operations can be carried on at night during the spells of good weather which the farmer finds so rare in these isles.

THE Nez Percé Indians of Fort Leavenworth, on the Missouri, have a system of flash-signalling by mirrors, which resembles the Morse code, but has not yet been interpreted by the white man.

TOMMASI'S RELAY.—We print on another page a report of the Anglo-American Telegraph Company's superintendent at Brest on the recent trial of this relay on the French Atlantic Cable. We saw this relay at the Paris Exhibition, where M. Tommasi exhibited to all comers its transcendant merits as a receiver on long submarine cables, by showing how many degrees it would deflect under a current sent through a block of dry wood. If M. Tommasi wishes to perfect his instrument for submarine signalling we would recommend him to adopt an artificial line of a nature somewhat less primitive than a plank.

A SEVERE snowstorm on the 4th of this month played great havoc among the Austrian telegraph lines for nearly a hundred miles round Vienna, and telegrams had to be forwarded by rail. The snow lay a metre deep, and all traffic was suspended.

NEW ZEALAND has now consented to join with Victoria, New South Wales, and South Australia in procuring a duplicate line of telegraph with England. At the meeting of the Eastern Extension Telegraph Company on November 6, it was stated that the carrying out of this work was temporarily postponed owing to the parliament of New South Wales having caused some alterations to be made in the agreement.

The Continental Telegraph Company, United States, has opened for business with six offices in New York, six in Philadelphia, and one in Trenton, New Jersey. The company will soon have four wires to Philadelphia, and wires to Baltimore, Washington, and Boston will soon be erected. There is already a brisk rivalry between it and the Western Union Company.

The Western Union Telegraph Company.—At the commencement of the fiscal year 1867, the Company operated 46,270 miles of line, 85,291 miles of wire, and had 2,565 offices. The capital and bonded debt amounted to 46,275,410 dollars. Thus each mile of wire was represented by 541.98 dollars of capital and debt. On the 30th of June, 1878, the miles of line had increased to 81,002, the miles of wire to 206,202, and the number of offices to 8,014. This was represented by a capital and debt (deducting the amount of the former owned by the Company) of 41,248,576.64 dollars, which averages within a fraction of 200.03 dollars per mile of wire. In addition to the property above enumerated, the company owns in stocks of other companies ,real estate, &c., over 8,000,000 dollars, which being deducted from the gross amount of capital and debt, the net average is about 160 dollars per mile. The number of messages transmitted has increased from 6,404,575 in 1868, to 33,918,894 in 1878. The number of messages annually transmitted per mile of wire has increased from 66 in 1868, to 116 in 1878. There has been a constant and rapid decrease in the average tolls per message from 104.7 cents in 1868, to 38.9 cents in 1878. The average cost of transmission has decreased in ten years from 63.4 cents to 25 cents per message, and the average profit from 41.3 to 13.9 cents. The decrease in the average tolls for the last year, notwithstanding the absence of competition and the increase of some competitive rates which had been reduced below the actual cost of doing the business was 4.7 cents. The further reduction of tolls without reducing the average profit per message will, it is believed, be warranted by the economies introduced into the expenditures which are now fairly inaugurated.—*Journal of the Telegraph*, U.S.

Nickel-plating.—We have received a small pamphlet on "Nickel-plating: its History and Useful Applications," from Mr. W. Elmore, 41, Queen Victoria Street. The process of nickel-plating dates as far back as 1843, it appears, when it was introduced by Professor Boettger. Boettger employed the double sulphates of nickel and ammonia, and the double chlorides of nickel ammonium, salts which are still found the best for the purpose. The Americans have recently improved greatly on the manufacture of these salts, and the refining of nickel. They have also applied the dynamo-electric machines instead of the voltaic battery to the electro depositing process; and we are told that there now over two hundred nickel-platers in New York alone. There are also many in France, Belgium, and other European countries. The advantages of dynamo-electricity for electro-typing will be seen when it is considered that a fine clear deposit or "shell" of copper 800 square feet in area, can be obtained from a dynamo-machine in less than three hours, without pin-hole, or other defects common to battery deposits. Mr. W. Elmore has introduced these American improvements into England, and is now carrying on the process of nickel-plating among us. He employs the Weston dynamo-electric machine, described in the Telegraphic Journal for April 15, 1878, and is agent for it in this country.

A great number of the rural communes of France who complained a short time ago of the excessive tax to be imposed on them for telegraphic weather reports have agreed to pay a reduced tax.

A Paris Exhibition gold medal was awarded to Sir William Thomson for his patent compass.

The Faraday lecture was delivered at the theatre of the Royal Institution on Tuesday, November 12th, by Prof. Ad. Wurtz.

At the first meeting of the Society of Telegraph Engineers for the coming session on November 13th, Mr. Andrew Jamieson, C.E., hon. sec. of the Society for Malta and the Mediterranean, read a comprehensive and instructive paper on "Cable Grappling and Cable Lifting." A full account of the paper will be given in our next.

Electric Resistance of Water at Different Temperatures.—MM. Exner and Goldschmidt find that the resistance of pure water uniformly decreases as the temperature rises, the resistance at 99° being about a third of what it is at 20°. A similar result was obtained with water acidulated with sulphuric acid.

The Aurora Borealis.—Prof. Edlund, of the Swedish Royal Academy, in a series of papers now being published in the *Phil Mag*, deduces the theorem that all other circumstances being equal, the resistance to the flow of the electric fluid from the atmosphere to the surface of the earth is greater at the equator and in the equatorial regions than at a certain distance from that circle, and that the resistance diminishes as the dip of the magnetic needle to the earth increases. And in this he discovers the cause not only of the strong disruptive discharges of violent tropic thunderstorms, but the rarer and gentler discharges of higher latitudes, culminating in the aurora borealis, in which the discharges are transformed into slow and continuous currents.

Influence of Electricity on Vegetation.—M. Celi is conducting experiments on this interesting subject similar to those of M. Grandeau to which we recently alluded. This mode of operation consists in growing two similar seedlings in equal quantities of the same soil, water and air; the only difference between their conditions of growth being that one of them is grown in a specially electrified atmosphere. The apparatus consists of a water-dropping collector, that is, an insulated metal basin of water from which a fine jet is constantly flowing and breaking in spray. This basin consequently takes the potential of the surrounding atmosphere, positive ordinarily, but sometimes negative in broken weather. The plant to be electrified is enclosed in a bell jar, and a wire runs from the basin to a set of metal points within the bell jar which give off electricity to the air let into the jar. The non-electrified plant is also enclosed in a similar bell jar and the same quantity of air is let in, but there is no special arrangement for electrification. On July 30 last, three grains of maize of equal weight were sown under each of these bell jars. On August 1 they sprouted, and for two days kept pace with each other in their growth; but on the third day the electrified plants began to develope more rapidly than the others, and on August 10 the relative heights of the plants were 17 and 8 centimetres.

Determination of Magnetic Moments in Absolute Measure.—In his experiments on the intensity of the earth's magnetism in absolute measure, Gauss determined the magnetic moment of the steel magnet

he employed to be 22·2 per gramme mass in C. G. S· units; and calculated that the mass of steel which would have to be placed in each cubic metre of non-magnetic matter in order to make up a globe of the same magnetic moment as the earth would be 3·55 kilogrammes of the same kind from which his magnet was made. Mr. Thomas Gray, B.Sc., now demonstrator in Physics, and Instructor in Telegraphy in the Imperial Engineering College of Tokio, Japan, but formerly a student of Glasgow University where the experiments were made, has been investigating the magnetic moments of similar bars differently tempered. His results are given in the *Phil Mag* for November. Mr. Gray finds that the magnetic moments of blue-tempered soft steel magnets are greater than those of glass-hard soft steel magnets for the same magnetising force, and that the difference between them diminishes as the magnetising force is increased. Magnets made of steel which had been heated to redness and then cooled in oil had comparatively small magnetic moments when cooled in cold oil; but the magnetic moments gradually increased as the temperature of the oil was raised til! it reached about 150° C., after which the magnetic moments were smaller the higher the temperature of the oil. The magnetic moments of these bars varied from 60 to 80 per gramme. Magnets made of steel which had been prviously heated to a bright red and suddenly cooled in water were scarcely so strong, after first magnetisation, as those of the same sceel which were after the same treatment again heated in oil to any temperature up to 310° C., and afterwards allowed to cool slowly in air. Experiments on magnets tempered from homogeneous iron wire supplied by Messrs. Webster & Horsfall for the 1865 cable gave results at variance with the above. Thus for glass-hard tempering the magnetic moment per gramme was only 20·22; for yellow tempering 17·18; for blue 11·29, and in the state as supplied 12·09. Mr. Gray found that the magnetic moments of these magnets were found to change very little, if at all, by lying nine months undisturbed, though on being allowed to fall they lost a slight percentage of force.

CONTACT ELECTRICITY.—Mr. J. Brown finds that with a dry couple formed of a plate of iron and a plate of copper in ordinary air, oxygen and carbonic acid makes the iron positively and the copper negatively electrified; but in sulphuretted hydrogen the iron becomes negative, and then the action ceases; the copper is covered by a thin coating of sulphur. The surrounding atmosphere, therefore, exercises an important influence on the generation of contact electricity.

EXCITATION OF ELECTRICITY BY PRESSURE AND FRICTION.—M. Herr H. Fritsch, of Konigsberg, gives in Wiedemann's *Annalen*, No. 9, 1878, the following interesting results educed by him. It is well known that certain crystalline bodies, such as cal spar, become electric by pressure when the pressure is applied by contact with a foreign material and not the substance itself. Thus two cal spars pressed together only show electrification at the surfaces in contact with the foreign bodies by which the pressure is exerted. It is generally stated that the electrification due to friction of two diverse substances depends exclusively on the nature of the substances, and M. Fritsch's experiments were undertaken to test the truth of this doctrine. Plates of zinc, copper, brass, and glass were stroked by him with a violin bow, so that they vibrated transversely and they became *negatively* electrified. But when the same bow was gently drawn lengthwise along the same part of the plate without producing a tone, the plate became *positively* electrified. When copper or zinc plates were whipped with white silk, so that the stroke was nearly perpendicular to the plate, the latter became strongly *positive;* if delivered so as to graze the plate it became as strongly *negative.* By *lightly* rubbing its entire rim with the silk it was always *negative;* but by *hard* rubbing of the rim with the same silk it was always *positive.* Coarse woollen cloth gave similar results in a less degree than silk. A square brass plate behaved like the copper plate; but a shallow scale pan of brass gave both electricities only when struck with silk and when well cleaned with acid. An old brass pound weight could not be excited at all with silk but only by a violin bow—the electricity varying according as it was applied to its broad base or its top. A small scale pan of silver gave both electricities only with silk, with wool it only became negatively electrified. A hard rubber plate always became negative when slowly stroked with a linen cloth lightly folded, and positive when quickly stroked. The surface of the hand produced the same effect as linen: only for the positive excitation the stroking had to be very rapid. White silk always made the principal cleavage surface of gypsum *positive;* but the subsidiary surface of lustrous fracture is always *negative*, while it makes no difference whether the latter surface is natural to the gypsum or is artificially produced by roughly scraping a surface of the principal cleavage plane. From a consideration of his experiments, M. Fritsch concludes that if two substances are rubbed against one another, the electricity excited in each of them may change into its opposite kind according as the pressure, velocity, or direction of the rubbing motion, &c., varies.

ELECTROLYTIC POLARIZATION.—Professor W. E. Ayrton and John Perry, from experiments carried on by sending a current from one or more Daniell cells through a voltameter and measuring its strength after a certain number of minutes, then suddenly reversing and observing the current strength a fixed time after, find that when the cathode is of copper wire, the anode being a copper plate, there is a quick falling off in the first current and a slow falling off in the reverse one; with a platinum wire cathode opposed to a platinum plate anode the reverse effect takes place; but with a platinum wire anode the same effect takes place. Messrs. Ayrton and Perry explain these facts by pointing out that since the surface of the wire in the voltameter is extremely small compared with that of the plate, the gases deposited on the wire will have more effect than those deposited on the plate in the polarization of the voltameter; and also that oxygen deposited on copper will, on account of its forming an oxide, be less operative in producing a reverse current than hydrogen; while on the other hand on account of the great absorption of hydrogen by platinum and of the difficulty of forming an oxide of platinum, it will be deposited oxygen that will produce the chief polarization in the platinum voltameter.

AN ELECTRICAL DIAPASON.—Mr. Geo. M. Hopkins, United States, has applied electricity to maintain the reeds in Lissajou's reflecting diapasons in constant vibration, for the production of Lissajou's figures. The reeds are adjustible as to length, so as to produce fractions of a tone and illustrate the phenomena of consonance and dissonance. In one form both reeds are conjoined to support a single mirror and give complex double tone figures.

PRODUCING THE ELECTRIC GLOW.—M. Boillot has invented an apparatus which gives a very bright glow in gases with a comparatively feeble electric tension. It consists of a glass tube 36 centimetres long and several millimetres internal diameter, filled with powdered

carbon, and hermetically closed; but having a platinum electrode sealed into one end. This fine tube is enclosed in a second medium sized tube so as to leave a very narrow annular space between. These concentric tubes are then enclosed in a third wider tube, and the space between the second and third tubes is also packed with powdered carbon. An electrode is also inserted into this carbon; and the ends of the latter are stiffened with shellac to prevent them falling out, for the extremities of this larger tube are open. Different gases are then passed up the annular space between the inner and middle tubes, and when the secondary poles of an induction coil, fed by several cells, are connected to the carbons, a phosphorescent glow is seen to traverse the gas all along the tubes. By means of a medium-sized induction coil and three or four Bunsen cells, M. Boillot has produced 50 milligrammes of ozone for every litre of oxygen gas submitted to the discharge.

ATMOSPHERIC ELECTRICITY.—In a recent article in *Appleton's American Popular Science Monthly*, Mr. Elisha Foote argues that when escaping steam infringes upon a conductor, the electricity generated in the latter is not due to friction, as Faraday believed, but to condensation of the steam. Blasts have been accidentally exploded by the steam from locomotives enveloping the naked wires of the electric fuse, and sparks have been observed on the switch board of railway telegraph offices when locomotives vented steam against the telegraph lines near by. These cases, however, speak at least as much for Faraday's explanation as Mr. Foote's.

MR. J. B. STEARNS has just succeeded in duplexing the Anglo-American Cable by his ordinary condenser system. The balance he has obtained, we understand, is absolutely complete, and the working of the siphon recorder (the instrument employed) is just as perfect as it was when single working was employed. Considering the marvellous sensitiveness of the siphon instrument this result is in the very highest degree satisfactory, and we congratulate Mr. Stearns on the success he has attained.

THE ELECTRIC LIGHT.—The New York papers announce that a new invention has been patented for the subdivision of the electric light by two electricians, named Sawyer and Man, of New York. The invention is said to be a very simple one, consisting of a small pencil of carbon little larger than a pin, and connected by wires with an electric machine enclosed in a hermetically-sealed glass globe filled with pure nitrogen gas. The new invention is known as the Electric Dynamite Light, and it is stated to emit a brilliant white light. The company asserts its ability to fit up lights equal to 30 gas, and state that by a very small switch in the wall the current of electricity can be divided so as to supply any number of burners. The meter difficulty has been overcome by an invention which will register the number of burners and the number of hours they are lighted. A company has been formed for the purpose of working the patent.

THE Leicester Corporation have resolved to obtain powers to light the city by electricity.

IT is proposed to test the electric light at Liverpool in front of St. George's Hall.

A MORE successful football match than that at the Oval was played in the old Deer Park at Windsor on Nov. 11. The light was supplied by two Siemens' machines, and two 50-cell batteries ranged along the sides of the field. No vain attempt was made, as at the Oval, to follow the ball, and the light was equable over the ground.

IT is stated that the Royal Docks at Flushing are to be lighted by 100 Werdermann lights. The same number will also be employed to light a portion of the city of Stockholm.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

THE USE OF THE MILLIWEBER.

SIR,—In the number of the *Journal Télégraphique* of March of this year, translated in your number of May 1st, M. Rothen, Assistant Director of Swiss Telegraphs, has questioned the policy and propriety of the introduction of the *milliweber* as a measure of the strength of currents used in telegraphy proposed by me in a paper read before the Society of Telegraph Engineers. His chief objection consists in deploring the destruction by me of the harmony and uniformity which exists in expressing other derivatives of the units in use by the submultiples *mega* and *micro*. But is this harmony and uniformity destroyed? I do not vary the unit. That has been fixed by the Committee of the British Association, and expressed by the Council of the Physical Society thus:—

"The practical unit of current is the current due to an electromotive force of 1 volt working through a resistance of 1 ohm. It is sometimes called the *weber*. We have

$$1 \text{ weber} = \frac{10^8}{10^9} = \frac{1}{10} \text{ of C G S unit of current."*}$$

Moreover the Committee of the British Association Committee on Units, in their first Report say, "For multiplication or division by a million the prefixes *mega* and *micro* may conveniently be employed according to the present custom of electricians . . . . . The prefixes *kilo, hecto, deca, deci, centi, milli* can also be employed in their usual senses before all new names of units."

In accordance with these views we use the microfarad, the megohm, the ohm, the volt, the milliweber, as the most convenient multiples and submultiples of the absolute units used in telegraphy. In other divisions of electrical science it is quite competent to use the farad, the hectohm, the decavolt, or the microweber, just as in mensuration we use the metre, millimetre, or centimetre, as it suits our convenience. We do not destroy harmony nor break through uniformity by doing so. General practice has confirmed the convenience of the milliweber in denoting the strength of working currents in telegraphic circuits, and I cannot admit that there is any inconsistency in adhering to this solution. The system has been introduced into the British Telegraph Department, and it is found to work very well and to be of very great convenience.

W. H. PREECE.

* Section 118. Illustrations of C G S system of units, published by the Physical Society of London.

TOMMASI'S RELAY.

[We were compelled in our last number from want of space to defer the particulars concerning the trial of this relay on the French Atlantic Cable, which were sent in by Mr. H. Weaver, general manager of that company. We are now able to give the substance of a report furnished to Mr. Weaver by the company's superintendent at Brest after M. Tommasi's official report to the French minister had been printed. It should be mentioned that M. Tommasi exhibits the supposed sensibility of his relay by working it through a block of dry wood; but the superintendent observed that this block of dry wood is plated with brass at its ends, and suggests that it therefore operates as a condenser.—Ed. TELE. JOUR.]

[COPY.]

THE ANGLO-AMERICAN TELEGRAPH CO., LT.,
BREST STATION.

1 *October*, 1878.

MEMORANDUM TO GENERAL MANAGER.

TOMMASI'S RELAY.

As before reported there is not only nothing new, but there is no merit whatever in Tommasi's Relay. In its construction the fundamental principles of electromagnetism are violated, and instead of extreme sensibility (as claimed) it is not by any means so sensitive as two different models which I have tried, *and which have worked* as mirrors on the cable. The first plan is due to Mr. Varley, but was designed to overcome the "kicks" and large vibrations which we had during the existence of the two large faults (subsequently taken out); it worked well as a galvanometer, having a mirror attached to the steel needle. The second is Henley's relay, patented at least 25 years ago, and which I adopted with a mirror to work on the cable—this it did as well as Varley's instrument. In both these plans the magnetic alteration of the electromagnet was utilised to the utmost, and there was but very little loss of power.

I now come to the veracious report, which is unveracious from what it conceals. We tried to work it *as a mirror with the full battery power* of 30 cells at S. P., and not a word could be read with it; two experienced clerks (Squires and Crilly) did their best, but could make out nothing but a letter here and there. The cause was, that to get signals the controlling magnet had to be so far removed, that definition was lost owing to want of sensibility. Not only was there this failure, but the needle being pivoted added its quota by continually "sticking" of its own accord.

Power was diminished to as low as 5 cells at S. P.—reading, of course, was out of the question, although it was tried, and all that was done was to count the number of right and left deflections, letter A or N in a minute; these were utterly unmeaning, as in no case would the deflection of the needle have sufficient force to make a relay contact the object of these experiments; the angular displacement of the needle would be hardly visible to the eye, although, of course, with the mirror attached, the deflection of the *spot of light* is large; however, we are not yet able to make contact with a spot of light, and until we can, a relay of *this* kind has not much chance.

As Mr. Tommasi throughout was so confident, although I told him at the outset that his relay would never work on this cable, I requested him to try it as *a relay—i.e.*, to make a contact. This was done with the full power at S. P. with the result that with the first current the needle hopelessly "stuck," and the *reverse current failed to detach it*. Here then the relay fails to do, under the best circumstances of power and no resistance in circuit, the very thing all these experiments are *made to show* that it *will* do. Now mark the contrast. With the Thomson galvanometer we *spoke* with L. P. with the lowest power used—viz., 5 cells and with no difficulty whatever, and without altering the adjustment used for 30 cells . . . To compare the sensibility of Tommasi's relay with Thomson's is an absurdity—the latter is at least ten times more sensitive.

The report to the Admiral (who was present) must be read between the lines, it only recounts what was seen, the deflections of the spot of light, and also what there was in the "Esprit de l'inventeur," of which there appears to be a good deal.

The Aide-de-Camp of the Admiral asked me in an aside what I thought of it. I replied that it would never work on this cable, and that there was no merit in it.

Mr. Tommasi, to judge from the memos attached, is evidently trying to make capital out of these previous experiments to the detriment of the company. On all sides I am raising enquiries if the relay has not had a great success on the Brest Cable. I think that if he should venture to ventilate these monstrosities in public he should be promptly extinguished.

I quite agree with you that "inventors" have too much indulgence from us. I think no experiments should be allowed on the cable until the instruments proposed have been examined by competent men, and their merits or otherwise established theoretically.

(Signed) THOS. ANDREWS.

New Patents.

4130. "Fog or alarm signals for the rails of railways." E. LUDLOW. Dated Oct. 17.

4161. "A commutator for double transmission and reversion of current with contact to earth for submarine telegraphy." E. EDMONDS (communicated by le Comte E. Siccardi). Dated Oct. 18.

4164. "Railway signalling." W. STRINGER and H. IVEY. Dated Oct. 19.

4173. "Means for signalling on board ship." G. C. PULFORD and H. J. BILLING. Dated Oct. 19.

4210. "Speaking telephones." J. F. BAILEY (communicated by G. M. Phelps). Dated Oct. 22.

4240. "Electric telegraph apparatus." W. R. LAKE (communicated by F. Tommasi). Dated Oct. 23.

4338. "Improvements in obtaining light by electricity, and in the means and apparatus employed therein." C. W. HARRISON. Dated Oct. 28.

4344. "Gas batteries for the production of electricity." F. J. ODLING. Dated Oct. 29.

4346. "Manufacture of telegraph cables." E. BERTHOUD and F. BOXEL. Dated Oct. 29.

4347. "Improvements in and appertaining to apparatus for producing the electric light." J. S. WILSON. Dated Oct. 29.

4367. "Improvements in electric telephony and apparatus therfore." J. F. BAILEY (communicated by F. L. Pope). Dated Oct. 29.

4388. "An improved method of and apparatus for producing electric light and regulating or controlling and measuring electrical currents for lighting, telegraphing, and other purposes." S. F. VAN CHOATE. Dated Oct. 31.

4403. "Apparatus for dividing and distributing currents of electricity." T. A. BELL. Dated Oct 31.

4407. "Applying electricity as a source of heat for industrial purposes." A. M. CLARK (communicated by C. Davis). Dated Oct. 31.

4438. "Improvements in preparing gutta-percha and other like substances suitable for insulating telegraphic conductors and for other purposes, and in machinery employed in the process and also improvements in making unions between various lengths of insulated conductors." E. J. TRUMAN. Dated Nov. 2.

4456. "Apparatus for producing, maintaining, and subdividing electric lights." F. H. W. NIGGINS. Dated Nov. 4.

4462. "Improvements in and appertaining to the production of the electric light." N. L. THOMSON. Dated Nov. 5.

4466. "Improvements in distributing electricity for the production of electric lights." C. STEWART. Dated Nov. 5.

4473. "Apparatus for obtaining electric light." F. GYE. Dated Nov. 5.

4476. "Means and apparatus for electric lighting." G. R. BODMER.

4502. "Lighting by electricity." G. G. BREWER (communicated by T. A. Edison). Dated Nov. 7.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

471. "Carbon electrodes." M. GRAY (communicated by N. E. Reynier, Paris.) Dated February 5, 1878. 2d. To avoid the useless combustion of carbon in electric lights, which takes place in rear of the luminous arc, it is proposed to plate them with some refractory metal, such as nickel or iron, by electrotyping. Nickel has the advantages of being cheap, easy of application, a high melting point, and little tendency to oxidise. The carbons are first smoothed with emery, cleaned, steeped in a lye of carbonate of soda or caustic potash, rinsed in water, electrotyped and dried at a temperature of over 100° F. *Not proceeded with.*

491. "Pneumatic Signal Bells." H. F. JOEL. Dated February 6, 1878. 6d. This consists of an improvement whereby an intermittent changing of a reciprocating into a circular motion is effected; and of an electric indicator, formed of a horse-shoe magnet, mounted on a fixed centre a little below the centre of gravity. When in its normal position the north and south poles are attracted by the sides of the cores of a small electro-magnet, such cores being connected by a cross-bar and enclosed by coils. The terminals of one coil are connected to the push battery bell; those of the other being connected severally to the adjusting button and the opposite pole of the battery.

492. "Battery Rheostats." SAMUEL JOSEPH COXETER. Dated February 6, 1878. 2d. This consists in forming resistances of powdered carbon or other conductor of electricity with powdered glass or other non-conductor of electricity. *Not proceeded with.*

570. "Gyrometers for Marine Engines." MORGAN BROWN (communicated by Schäffer and Budenberg, Buckan-Magdeburg, Prussia). Dated February 11, 1878. 6d. This consists of a dial which by means of a electro-magnetic connection with the engine informs the captain of the ship as to the working of the latter.

584. "Mode of Transmitting Audible Signals." HENRY EDMUNDS, Jun. Dated February 12, 1878. 6d. This consists in sending sound signals through water without a line. To communicate between the shore and a boat, a sounding apparatus, formed of a bell in a water-tight box, is sunk in the water, and the bell is worked mechanically or electrically from the shore. In the boat is a sound receiver which is dipped into the water, its upper end being brought near the ear of the listener. The pulsations of the bell are transmitted through the water from the shore apparatus to the boat. The pulsations may be received on an automatic recording apparatus. It is proposed to use this apparatus as a signal between ships at sea, or attached to buoys in still water near shoals; the bells being actuated by a sea-water battery and the alarm heard by the ship on applying a receiving apparatus, such as a spar of wood, to the water.

596. "Applying Electricity." EDWARD B. BRIGHT. Dated February 13, 1878. 6d. This consists in indicating the locality of an outbreak of fire by causing the thermostat or signal indicating the fire to insert distinctive resistances into the circuit at that point—these resistances indicating themselves at the fire station.

609. "Circuit Closers for Torpedoes." M. H. ATKINSON. Dated February 13, 1878. 8d. The closer is moored in an upright position beside the fuse, the circuit running through both. When the closer is forced out of its perpendicular position in the water by a ship the circuit is completed by a metal disc striking the outer case and the torpedo fired.

610. "Electric Apparatus for Mastering Horses." ADÈLE ENGSTRÖM. Dated February 13, 1878. 6d. This consists in applying a powerful current from an induction apparatus to the bit of a restive horse, so that the shock passes through the horse's mouth.

611. "Electric Telephonic Apparatus." PROF. G. BELL. Dated February 14, 1878. 6d. This consists in employing a tubular magnet in the Bell telephone, and in attaching the plate to the pole which was formerly unused. Another improvement is to attach the coil itself to the vibrating plate, so as to let the coil project from the plate and thereby cause both plate and coil to vibrate before the pole of the magnet.

617. "Telephones." H. J. HADDON (communicated by G. B. Richmond, Lansing, Mich., U.S.). Dated February 14, 1878. This consists of a telephone in which a platinum wire or style attached to the back of the diaphragm dips into water in front of a contact separated from it by a space of the liquid. The style and contact are in circuit with the line and a battery. When the diaphragm vibrates under the voice the style moves to and from the contact regulating the resistance of the intervening water and setting up undulatory voice currents received by an electro-magnetic telephone.

General Science Columns.

DEATHS.—Science has sustained two losses more, in the persons of Mr. Thomas Belt, F.G.S., and Mr. Thomas Grubb, F.R.S. Mr. Belt is best known as the author of the "Naturalist in Nicaragua." He was an engineer as well as an able geologist and traveller. He died in Colorado. Mr. Grubb, the well-known mechanician, was originally destined for commercial pursuits, but naturally inclined towards science. He displayed marked originality of invention in the designs of his instruments and the equipment of astronomical and magnetic observatories. He was elected a Fellow of the Royal Society in 1864, on his completion of the great Melbourne telescope. Dr. Peterman, the eminent geographer of Gotha, is also dead.

MECHANICAL EQUIVALENT OF HEAT.—The newest value of Joule's equivalent, as given by Dr. Joule, from the experiments of the Special Committee of the British Association for its determination, is as follows:—The heat required to raise a pound of water, weighed in vacuo, from a temperature of 60° to 61° Fahrenheit at the sea level in the latitude of Greenwich, is equivalent to 772·55 foot pounds of work done. The committee are now engaged in determining the true position of the freezing and boiling points of the thermometer when the effects of imperfect elasticity of the glass are eliminated.

THERE is said to be a terrestrial globe in the Jesuitic Library of the Lyons Lyceum, made in 1701 by two Brothers of the Third Order of St. Francis, which delineates in detail the great central African lake system recently explored by English and American travellers.

PHYSICAL ORIGIN OF NEBULAE.—In a recent paper on this subject, Dr. Croll endeavours to attribute the origin of the sun's heat and formation of nebulae to the collision of bodies in space. He shows that were the origin of the solar heat referred to gravitation, the other tenable hypothesis, the amount of energy from that source could not keep up the present radiation from the sun beyond 20 or 30 million years; whereas the mere collision of two bodies each one-half the mass of the sun and moving at a velocity of 476 miles per second, would generate an amount of heat capable of supporting the present solar radiation for 50 million years. Each pound of the mass would, by the stoppage of its motion, possess heat enough to melt 90 tons of iron; and the whole mass would be converted into an incandescent gas or nebulae, with a temperature of certainly more than 140,000 times that of the voltaic arc.

SPEAKING MACHINES.—As a contribution to the history of the phonograph and megaphone, we give the following quaint extract from the "Natural Magick" of John Baptista Porta, a Neapolitan, London, 1658. In the 19th book he says, "I have read that in some Cities there was a Colossus of Brass placed on a mighty high Pillar, which in violent tempests of wind from the nether parts received a great blast that was carried from the mouth to a Trumpet, that it blew strongly, or else sounded some other instrument, which I believe to have been easie, because I have seen the like. Also, I read in many great men of authority, that *Albertus Magnus* made a head that spoke; yet, to speak truth, I give little credit to that man, because all I made trial of from him I found to be false but what he took from other men. I will see whether an Image can be made that will speak. Some say that *Albertus* by Astrological elections of times, did perform this wonderful thing; but I wonder how learned men could be so gulled, for they know the stars have no such forces. Some think he did it by Magick Arts. And this I credit least of all, since there is no man that possesseth himself to know those Arts but Impostors and Mountebanks, whilst they cheat ignorant men and simple women, nor do I think that the Godly man would possess ungodly Arts. But I suppose it may be done by wind. We see that the voice or a sound will be conveighed entire through the Air, and that not in an instant, but by degrees in time. We see that Brass guns, which by the force of Gunpowder make a mighty noise, if they be a mile off, yet we see the flame much before we hear the sound. So hand Guns make a report that come at a great distance to us, but some minutes of time are required for it, for that is the nature of sounds; wherefore sounds go with time, and are entire without interruption, unless they break upon some place. The Echo proves this, for it strikes whole against a wall, and so rebounds back, and is reflected as a beam of the Sun. Moreover, as I said in this work, words and voices go united together, and are carried very far entire, as they are spoken at first. These, therefore, being laid down for true grounds, if any man shall make leaden Pipes exceeding long, two or three hundred paces long (as I have tried), and shall speak in them some or many words, they will be carried true through those Pipes, and may be heard at the other end, as they came from the speaker's mouth; wherefore, if that voice goes with tune, hold entire, if any man as the words are spoken, shall stop the end of the Pipe, and he that is at the other end shall do the like, the voice may be intercepted in the middle, and be shut up as in a prison and when the mouth is opened, the voice will come forth, as out of his mouth that spake it; but because such long Pipes cannot be made without trouble, they may be bent up and down like a Trumpet, that a long Pipe may be kept in a small place; and when the mouth is open, the words may be understood. I am now upon trial of it; if before my Book be Printed the business take effect, I will set it down; if not, if God please, I shall write of it elsewhere."

On the megaphone, the learned Porta is equally ingenious, but not quite so happy. He says, "In my Opticks I showed you spectacles, wherewith one might see very far. Now I will try to make an Instrument, wherewith we may hear many miles; and I will search out a wood, wherewith that may be performed better and with more ease. Therefore to find out the form of this Instrument, we must consider the ears of all living creatures, that hear best. For this is confirmed in the Principles of Natural Philosophy, that when any new things are to be invented, Nature must be searched and followed. * * * And *Aristotle* saith that Horses, Asses, Dogs, and other Creatures that have great ears, do always stir them about, and turn them to hear noise, Nature teaching them the use of those parts; and we find that they hear less that have their ears cut off: wherefore it is fit that the Form of the Instrument for hearing be large, hollow, and open, and with screws inwardly. For the first, if the sound should come indirectly, it would hurt the sense; for the second, the voice coming in by windings is beaten by the turnings in the ears, and is therefore multiplied, as we see in an echo. The sea-Periwinkle is an argument to prove it, which, being held to the ear, makes a light noise. Now it remains to speak of what matter it must be made. I think of porous Wood, for the holes and pores are passable every way; and being filled with air, they sound with every small stroke: and amongst the porous Wood, is the Ivy, and especially the tree called Smilac, or Woodbind, for a Dish made with Ivy, will let out water, as I said. Wherefore *Pliny*, speaking of the Woodbind, saith, "It is proper to this matter, that being set to the ears, it will make a small noise." And in another place, I said that the Woodbind, Ivy, would sound, if set to the ear. Therefore fit your Instrument to put into your ear, as spectacles are fitted to the eyes."

EDISON'S "BLIND" INK.—This ink, which swells up on hardening so as to be in relief from the paper, is now being tried on wood, and it is thought that a variety may be found which will be hard enough to print from, so that artists may draw their designs with it, and dispense with the engraver.

SCHNEIDER'S TELESCOPE.—We learn from an Austrian journal *(Bericht der K. K. Academie der Wis-*

chenschaften) that M. Schneider, a mechanician of Vienna, has invented a telescope which enables an observer to see simultaneously and distinctly, without altering the distances of the lenses, two different objects in the same line, one very near, and the other at a great distance. The priority of the invention is attested by the Vienna Academy of Sciences. We believe that Newton, Gallileo, Frauenhofer and Ploessal, have attempted in vain to construct a telescope of this sort. Schneider's telescope cannot fail to be useful, not only in astronomical and in naval or military observations, but in surveying and in physical experiments. If the same principle can be applied to the microscope it will be of great value for comparing specimens. Will some of our optical specialists give us their opinion of this invention?

THE MILK OF THE COW-TREE.—No tree aroused the imagination of Humboldt so keenly as the *Broximum Galactodendron*; or *palo de leche*, or cow-tree, which grows upon the slopes of the cordilleras of Venezuela. As the nutricious juice of this tree is allied very closely to the rubber tree of Brazil—and, indeed, may yet come to supply a rubber to the European markets—the following account of its composition, communicated to the French Academy of Sciences by M. Boussingault, may not be without interest. The cow-tree grows to a height of from 15 to 20 metres; its leaves are oblong, alternate, and terminated by points. The creamy juice is obtained by cutting into the inner bark. It is used by the natives in place of cow's milk. The analysis of 100 parts of milk, containing 42 parts of fixed matter, is as follows:

Wax and saponaceous matter ...	35·2	
Sugary substances	2·8	
Caseine, albumen	1·7	
Earths, alkalies, phosphates ...	0·5	4·0
Indeterminate substances	1·8	
Water	58·0	
	100·0	

The cream of the cow, according to an analysis of M. Jeannier, contains:

Butter	34·3
Milk sugar	4·0
Caseine and phosphate	3·5
Water	58·2
	100·0

It will be observed that wax appears in the vegetable milk in about the same proportion as butter in the animal.

City Notes.

Old Broad Street, November 12, 1878.

THE tenth ordinary general meeting of the Eastern Extension, Australasia, and China Telegraph Company (Limited), was held on the 6th inst. at the City Terminus Hotel, under the presidency of Mr. John Pinder, M.P. The report of the directors, which was mentioned in our last issue, was taken as read.—The Chairman, in moving its adoption, said he was glad to be able to congratulate the shareholders on the fact that their cables were to-day in good working order, which they had not been very often able to say during the last six months. At the present time the traffic was going on in a very satisfactory way. The gross earnings for the half-year ending 30th June last were £135,482, which as against £140,436 earned in the corresponding period of last year showed a decrease of £4,954. Of this amount nearly £2,000 was lost in exchange, and the remainder was due to a slight falling off in revenue, which he was glad to say had been made up since the close of the half-year. The expenditure in the same time time had been £61,222, as against £48,417 in 1877, an increase to the extent of £12,805. This was accounted for in the following manner:—Station expenses caused principally by the opening of the Rangoon cable, staff for a night service during the Eastern crisis, and establishment of the duplex working on the Madras-Penang line, £2,690; expenses of conference at Melbourne, £898, and cost of new land lines and instruments for establishment of duplex system, £4,342. Those were sums that would not have to be repeated. The duplex system practically gave them for working purposes an additional cable, as they were able to send simultaneously from either end, both messages going forward at the same time. The heavy amount of over £3,000 for repairs was caused to a considerable extent by the well-known "teredo," which was found in shallow water. The result of its ravages was that they had to make repeated repairs, small in themselves; but still damage to the extent of a pin's point caused as much interruption as if the cable were cut to pieces. They had turned a great deal of attention to this subject, and in connection with the Telegraph Construction Company, had now got something like 150 miles of experimental cable being tried, which he believed it would be impossible for any insects to penetrate. If so it would prevent a constant drain upon their resources. The depreciation of ships was £2,000, and this amount would continue until they were brought down to the price at which they could be at any time sold. The net revenue was £74,260, or a decrease of £17,759 on the corresponding six months of 1877. After paying the two interim dividends they carried forward £24,323 as against £13,299. Their new ship, the *Sherard Osborn*, which had cost them £45,000, had now arrived at her station, where she had already been of great service. The question that the directors expected to have brought forward to-day at the special meeting—the duplication of the Australian Cable—was one that they would have to postpone for a short time. They had received telegrams from time to time from Colonel Glover, who was now in Australia, to the effect that he had got the different Governments of the Colonies to agree to the duplications and to pay £32,000 a year. They had brought the matter to such a satisfactory point that they had intimated they were going that day to take powers to carry it out. Colonel Glover was assured by the Government of New South Wales that the terms were approved, but they had to be affirmed by the Parliaments of Victoria and New South Wales. The former did so unanimously, but the latter, ofter two nights' discussion made some alterations that had to be referred to the Senate, who made still further alterations, so that the agreement which the directors expected to read that day as complete was now in abeyance. He (the chairman) had no doubt that they would arrive at a satisfactory conclusion in the course of a week or ten days, and he therefore thought they had better not discuss the matter until the directors were ready with an agreement to which they would ask approval.—The Right Hon. W. N. Massey, M.P. (vice-chairman): I beg leave to second that. Some discussion then followed upon the accounts, in which Mr. Marshall, Mr. Christie, Mr. Abbott, and Mr. Newton took part.—Mr. Marshall: May I ask whether any other tenders have

been asked for than from the Construction Company for the new cable? It is an important question.—The Chairman replied by saying: It is a very important question indeed for the shareholders to have a cable in which they and the directors can have perfect confidence (hear, hear) and therefore I am prepared to answer, so far, your question. We have not asked for tenders from any other company but the Construction Company (hear, hear). We shall get a special cable manufactured, and have requested one of the leading firms of electrical engineers of London—Messrs. Clark and Ford—to go most carefully into the cost of the cable, taking the whole of the different materials into account and they have given us a certain sum. We also got Sir James Anderson, who has a technical knowledge of the value of these different articles to go into it, and these gentlemen came to within £8,000 of each other as to the cost of the cable. I may tell you that, when we do make a contract for the cable, we shall save very considerably upon the estimate of the value of the cable that we got from our engineers, and also from Sir James Anderson. Having said so much, I think it must satisfy you that we have looked to quality, and we have looked to another thing. I hope that these debentures will be floated at 5 per cent., and our arrangement will be with the contractor that, if there is any difficulty at all in floating them, they will be ready to aid us in the transaction (hear, hear). I can only tell you that, from the experience I have had of getting cables from other parties, I am here to prove by experts that what we have done with the Construction Company is cheaper and more satisfactory to us than you could have dealt elsewhere (hear, hear). With these remarks, I beg to take the sense of the meeting on the resolution before them. Those who approve of it will please to signify the same in the usual way—— on the contrary. It is carried with one dissentient. The business of this meeting is closed, and we come to the extraordinary general meeting, and I beg to propose "That the extraordinary general meeting be adjourned to Wednesday, December 4, at 2 p.m., at the Terminus Hotel, Cannon Street." Lord William Montagu Hay having seconded the proposition, the chairman then put the resolution to the meeting in the usual way for and against, and it was carried. He then said: That is all the business, gentlemen, and I hope that when we meet a month hence we shall be able to state that the contract is settled with Australia; and I would just say one word in regard to the contract—that I am perfectly satisfied that, if it is carried out in the terms and in the spirit which your directors have before them, it will give you an additional security, and I hope will materially develope the traffic between this and Australia. The Australians are so alive to the value of telegraphic communication with England that, as one of the speakers pointed out, as being a thing unknown to the colony before, they have really united to subscribe an annual sum for a duplicate cable, so as to ensure that continuous communication with England which they so much value. That continuous connection with England will give, at all events, an additional security to you (hear, hear). A vote of thanks was tendered to the Board of Directors for their able management of the Company's business.

The Direct United States Cable Company notify on and after the 16th inst., the payment of an *interim* dividend of 5s. per share, being at the rate of 5 per cent. per annum, for the quarter ending 30th September.

The Stock Exchange Committee have allowed 1,500 ordinary and 1,500 preference additional shares of the Globe Telegraph and Trust Company (Limited) to be added to the 154,000 shares of each class already in the official list.

Notification was given on the 4th inst. of the restoration of the Eastern Extension Telegraph Company's Java-Singapore Cable; also on the same date of the Great Northern Company's Amoy-Shanghai Cable, thus re-establishing direct telegraphic communication with Java, Australia, and Shanghai *via* Eastern.

Gas shares have slightly recovered from the tremendous depression noticeable when last we wrote. During the week just ended Gas Light and Coke A ordinary rose 7; ditto H preference, 2; Commercial, Imperial, Continental, and London, 5; Bombay, Continental Union, European, and Para shares, ½.

We think a considerable advance has been effected in the matter of electric lighting by M. Werdermann, whose system is given fully in another column, and we shall be interested to note what success it achieves when his lamps are placed at some distance from each other.

Much has been asked and said about the cost of the electric light when compared with that of gas. We have seen no figures relating to this subject on which much value can be set. Even usually well-informed journals have published comparisons on the subject, omitting altogether charges for interest on capital expended for machines, motive power, &c. As the various machines, lamps, and appurtenances are improved the figures change rapidly; the subject is, therefore, a rather difficult one to analyse. Most of the data given have been quoted by sellers and not users of the apparatus, and, without thinking for a moment that our large manufacturing firms would consciously mislead the public, it is but natural to assume that the most favourable colouring consistent with truth has been given to their reports hitherto published. In making a comparison, the cost of machines, lamps, conductors and motive power, must be ascertained, and the interest on this amount, together with the cost of skilled employees, lubricants, carbons, renewals of brushes, and allowance for depreciation generally, set against the price of gas for a similar lighting power, which price will include the whole cost, excepting only the fittings of the consumer.

The following are the late quotations of telegraphs:—Anglo-American, Limited, 59½-60; Ditto, Preferred, 85-86; Ditto, Deferred, 34¼-35½; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6⅜-6⅝; Cuba, Limited, 8-8½; Cuba, Limited, 10 per cent. Preference, 15¼-15¾; Direct Spanish, Limited, 2-2½; Direct Spanish, 10 per cent. Preference, 9½-10 xd.; Direct United States Cable, Limited, 1877, 12¾-13; Eastern, Limited, 7⅛-7⅜; Eastern, 6 per cent. Debentures repayable October, 1883, 103-106; Eastern 5 per cent. Debentures repayable August, 1887, 98-100; Eastern, 6 per cent. Preference, 10⅞-11⅛; Eastern Extension, Australasian and China Limited, 7-7¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 102-105; German Union Telegraph and Trust, 7¾-8¼; Globe Telegraph and Trust, Limited, 4¾-5; Globe, 6 per cent. Preference, 10¼-10½; Great Northern, 7⅝-7⅞; Indo-European, Limited, 18½-19½; Mediterranean Extension, Limited, 2¾-3¼; Mediterranean Extension, 8 per cent. Preference, 8¾-9¼; Reuter's, Limited, 9½-10½; Submarine, 215-220; Submarine Scrip, 1⅞-2⅛; West India and Panama, Limited, 1⅞-2⅛; Ditto, 6 per cent. First Preference, 7¾-8¼; Ditto, ditto, Second Preference, 7½-8; Western and Brazilian, Limited, 2¾-3; Ditto, 6 per cent. Debentures "A," 88-93, Ditto, ditto, ditto, "B," 84-88; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds; 108-112; Ditto, 6 per cent. Sterling Bonds, 100-102; Telegraph Construction and Maintenance, Limited, 29½-30½; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅜-2⅝; India Rubber Co., 29-30.

THE TELEGRAPHIC JOURNAL.

VOL. VI.—No. 140.

THE GAS COMPANIES AND THE ELECTRIC LIGHT.

NOTHING could be said more seriously for the injury of gas property than some of the remarks which have been made by the companies themselves. We must wait to see what Mr. Edison is ready to do before we can predict the turn of affairs which will happen. What Mr. Edison is said to have accomplished has fairly taken those who know something of this matter by surprise. Inventors are, as a rule, very cautious men, and it is an unusual thing for an inventor, who is on the threshold of a grand discovery, to exclaim, "Eureka" until he is prepared to publish the whole affair.

As Mr. Edison has not filed his complete specification, we may be sure he has not yet matured his plans. Other workers are in the field, and whilst some of them, by a vague statement, may, in their specifications, anticipate some of Mr. Edison's ideas, the fact that the invention was so overtly put forward as a secret may seriously jeopardise his position legally, should any subsequent specification be filed closely treading on his heels.

We would remind our readers of the celebrated case of Ransome *versus* Howard, where one of the parties filed, as is usually done, a specification for an invention. The other, before the six months had expired, filed a complete specification, and took out Letters Patent for what was held to be the same thing. The case was ultimately carried to the House of Lords, and although it may seem very hard against the party who was the first in the field, the ruling was against him, the decision being, that the provisional protection was intended to safeguard an inventor as against his own workpeople, and did not apply to the outside public. This should at any rate make inventors very cautious, for if an individual re-discovered Edison's secret even now, and filed his complete specification, Edison would find himself bowled out entirely.

During the past two months the road to the English Patent Office has been kept warm, not by Mr. Edison's footfalls, but by many eager and enterprising spirits, some of whom may outstrip him in success before his plans come on the scene at all.

Whatever may be the issue of what is now proposed and being tried, we may be sure that the electric light will be sooner or later a stimulating competitor to the gas companies.

Under the circumstances we consider the gas companies are not acting very wisely. At one meeting it was said that gas could be so reduced in price to the consumer as to disbar the hope of the electricians. Now, are the companies best consulting their own interest in waiting for the new light to be pronounced upon before they take action? Let our corporations and municipal authorities erect the plant for the electric light, and it will be too late for the gas companies to raise their voice on the diminished cost to the consumer, for the electric light, when the plant is brought together, will be so cheap compared with gas that the Companies, with their 2s. 6d. per 1,000 cubic feet, would be nowhere.

With regard to lighting streets, it has been said that the diminished revenue on this score to the companies would only affect that revenue by one per cent. This is manifestly an exaggeration, it is probably a much more important item of, revenue. Railway stations could be most economically fitted up with the electric light. Factories and large buildings are just the places where the new light can to the very best advantage be employed; so that the only field at present apparently secure to the companies are the "side streets" and private houses.

We must, however, deal fairly with the gas companies, and if they consent to do for us what the electric light may fail to do, or at any rate as cheaply as is done with gas, are we justified in withholding from them a suitable compensation? We can hardly believe the companies would adopt such a short-sighted policy as "to take it out" of their private consumers.

That the matter is an unpleasant one for the companies there can be no doubt, and if it is a fact that the investments in this country are £130,000,000 in gas shares and stocks, we hope that the change will be transitional, even if it is to be extensively adopted.

For the sake of success in electric lighting we hope that the gas companies will not be allowed to tamper with their rival, for such a result would be to strengthen their monopoly, which, as far as gas itself is concerned, gives the gas companies what they like, and their customers what they can get.

Any attempt on the part of the gas companies to obtain Parliamentary powers over a rival system of lighting must be strongly opposed. We are glad to see that many members of the House of Commons have spoken freely on the electric light; We have, therefore, no fear that the Gas Companies will persuade our Legislation that the new method of lighting will be best carried out in their hands or that they will have any business with the light

at all, unless it be for lighting up their workshops. There are, indeed, signs that the companies recognise the hopelessness of attempting to monopolise the electric light, and are confining themselves to developing the capabilities of gas.

THE SOURCE OF SOUND IN THE TELEPHONE.

AN EXPERIMENTAL INVESTIGATION BY AID OF THE MICROPHONE.

By PROF. D. E. HUGHES.*

(*Continued from page* 455.)

PENDULUM EXPERIMENTS.—In order to verify the preceding experiments on a different system of observation, by means of which the attractions and repulsions could be rendered visible and the force estimated by its mechanical movement, the following instrument was constructed :

wire, the coil being brought within ½ inch of it, the key being opened and closed synchronously with swing of pendulum so as to sustain and increase its swing, gave but feeble results, the maximum swing being but ¼ inch. Iron bar introduced into coil improved it, giving ½ inch swing. Magnet in coil gave strong effects, but in order to measure its full effect it was necessary to remove the coil to 2 inches distance, yet even here the effect was remarkable, giving full 2 inches swing. Each closing of the circuit was marked by a strong action on the rod ; and taking into consideration the increased distance of the coil, the effect was fully twenty times as strong with the induced magnetic field as with the simple coils alone. The magnet, when removed from the coil and placed at the back of the rod, the coil thus being on the opposite side, gave feeble results, the swing being but ¾ inch. If the magnets were placed at both ends, one in the coil and the other at the back of the rod, the swing was but 1 inch ; the rod had an unstable movement as it fell under the influence of one or the other magnet. The swing was at its maximum when both magnets were placed in

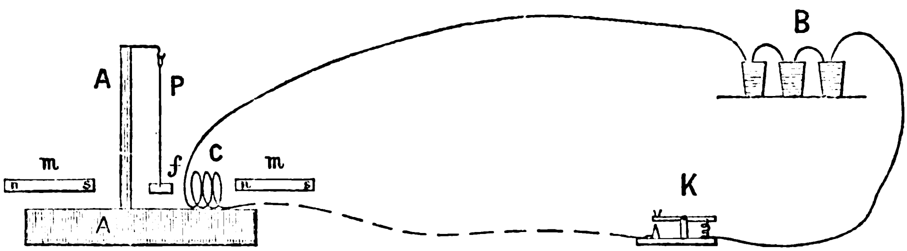


FIG. 2.

A A. Wooden stand for sustaining the pendulum wire.

P. Thin copper wire, hair, or glass thread, to sustain the piece of iron, or "bob," under observation, and by the weight of the bob and its freedom of motion to serve as the rod of the pendulum.

f. Iron, copper, or other metal bob under investigation ; the degree of continued swing being the approximate and comparative measure of the force of action upon the bob from the coil, magnet, &c.

C. Coil in communication with the three Daniell's elements. This could be shifted near or far at will by a slide.

m m. Magnets, which could be used at will to induce a magnetic field.

K. Key for closing the circuit, giving at will prolonged or momentary currents. By the introduction of a hammer and anvil microphone, undulatory currents could be used ; but as no difference was found except in the degree of force exerted, we will speak only of the maximum effect obtained in making and breaking circuit by the key.

B. Battery.

XXV.—A small rod of iron wire ½ inch long, ⅛th inch in diameter, being affixed to pendulum

* Communicated by PROF. HUGHES to the *Telegraphic Journal.* We state this because the article has been copied in a mutilated form by a contemporary.

the coil, the similar poles being together ; it then reached 2½ inches.

XXVI.—Horse-shoe magnet or contrary poles being introduced into the coils in place of the bar magnet, the iron rod at once placed itself at right angles, and on the passage of the current through the coils, would turn on its axis slightly as a galvanometer. Notwithstanding this it commenced at once to swing, giving at its maximum 1 inch range. At first glance we should have supposed that the rod would simply have turned on its axis, but as the attraction is much stronger than the repulsion, we had here the differential results, of this action, and consequently this explains why we hear the sounds in a telephone whose magnets consists of two separate and opposing poles.

XXVII.—Copper, zinc, silver, and all non-magnetic bodies attached to the pendulum in the place of the iron show feeble repulsion where iron shows strong attraction. The swing obtained from copper, &c., was very feeble, not being more than ¼ inch at the maximum, and that only when the coil was as near as possible. No effect whatever could be obtained by the coil alone, but the introduction of the magnet at once gave evidence of the repulsions.

XXVIII.—A coil of fine covered copper wire placed on the pendulum gave no repulsions as long as the circuit of this coil was open, but on joining

the wires so as to form a closed circuit in which the included currents could circulate, clear repulsions were obtained.

(This proves that the movement obtained is due to the reaction of the induced currents upon the magnetic field, and as these currents are in the contrary direction to the direct or primary currents, repulsion instead of attraction takes place. This fully explains the reasons of repulsion in all the non-magnetic conductors, and also why we obtain sounds from such bodies.)

XXIX.—A coil of fine (covered) iron wire having replaced the copper coil, gave strong attractions, and but little difference could be observed when the circuit of the coil was closed or open, owing to the fact that the greatly increased swing necessitated the removal of the primary coil. In the case of the copper coil we had but one-eighth inch swing at the maximum, but with the iron coil 2 inches. (No doubt the induced current in the closed iron coil reacted upon the magnetic field tending to feeble repulsion, but the strong magnetic movement of the iron so overpowered it as to render it almost inappreciable.)

XXX.—All non-conductors gave no evidence of movement simply from want of a conducting body in which the induced currents could circulate. With copper, zinc, &c., short momentary contacts were quite as effective as prolonged ones; but with iron a very marked difference was shown in favour of prolonged contacts, thus showing that the movement was not due to any instantaneous molecular changes, but simply to electro-magnetic attractions, as we have all long since understood.

XXXI.—If we take two small bars, one of tempered steel magnetised, and the other of soft iron, both being exactly the same size, and placed alternately on the pendulum, we find that the maximum of swing is obtained with the steel bar, it giving 3 inches swing for 2 inches of soft iron. If we place in the coil a bar of soft iron similar in size to the permanent magnet, we obtain but 1 inch spring. Knowing as we do, that iron possesses far greater power as regards electro-magnetic changes under a given force than steel, the superior results obtained by the use of a steel magnet, both in the coil and on the pendulum, can only be due to a greater change in the field of force, and not to electro-magnetic molecular change in the magnet itself.

(To be continued.)

PRITCHETT'S IMPROVEMENTS IN TELEPHONES.

THE DUAL TELEPHONE.—Telephones as now generally used consist of the well-known cases held by the hand, and are applied to the ear and to the mouth for receiving and transmitting purposes. By a patent recently published, the disadvantage and uncertainty consequent upon shifting the instruments, or by using two separate instruments, is obviated. One form of instrument covered by the patent is shown by fig. 1. One end of a hinged and covered magnetised bar is fitted with a padded receiving ear-piece, and its other end is fitted with a transmitting mouth-piece. This instrument is held by one hand, and is adjusted to the ear and mouth by one motion, obviating any shifting or the necessity of having to use two telephones.

Another great advantage is that this form of instrument leaves one hand free for writing or reporting as the message arrives at the ear, whilst at the moment after the user can transmit or ask for a repetition of a message or word by means of the mouth-piece. This form, the patentee, Mr. G. E. Pritchett, F.S.A., of Bishop's Stortford, Herts., terms a dual telephone.

THE TRIPLE TELEPHONE.—Another form (fig. 2) shows a nearly similar arrangement in a triple form. It has two ear-pieces for receiving, and one mouth-piece for transmitting purposes, and is held by the handles A shown in the figure. The ear-pieces in both figs. being padded, deaden external sounds, and make the instruments, which are light and handy, very useful. Both instruments can be folded up and placed in the pocket or in a small case, and connected and disconnected at will with circuits as required.

Fig. 3 is a very handy form of instrument where it is desirable to have both hands free for writing, &c. It consists of a pair of bent magnetised and covered bars fitted with padded ear-pieces and adjusted to the ears. These ear-pieces are secured to the ears by an elastic band passing under the chin and over the head. The wires are connected up in the usual way, and brought from any convenient point or from a reel as may be desired, thus both hands of the person receiving are free, and he can report, write, and manipulate with other instruments at will. A tube is inserted above the disc for transmitting as required. It cannot fail to be seen how useful such instruments will be to gentlemen connected with the press or law courts; whilst for transmitting purposes Nos. 1 and 2 are adapted for relay, as the operator can transmit as rapidly as he receives, it being only necessary to connect up the mouth-piece with the required circuits by bringing the electric switch into use.

Fig. 4 shows Mr. Pritchett's method of capping existing telephone-cases so as to form them into multiple instruments. The caps are formed of any suitable material, and are attached to the top of the telephone. A clip at B is adjusted to fasten on to a coat collar, or a strap or button may be used to suspend the telephone. From the cap or caps a self-adjusting tube is carried up and adjusted by a pad or otherwise to the ear; or the tube may also be carried on to the other ear, and secured by an elastic band, so as to bring both ears into use for receiving. A mouth-piece is also formed in the caps for transmitting purposes, as shown at C. Thus the hands of the persons using the telephones are entirely free for writing or manipulating, as before mentioned. One telephone takes the place of two or more if desired.

Fig. 5 shows ordinary telephone cases, mounted on an adjusting stand, which can be placed on a table. Above the telephones a horizontal hollow bar is adjusted, provided with projecting pieces fitting down into the mouth of the telephones. From this bar several elastic tubes can be led off and handled, and used for receiving or transmitting purposes. For example, a number of reporters could, one and all, receive and note down "speeches" or "evidence" at the same moment.

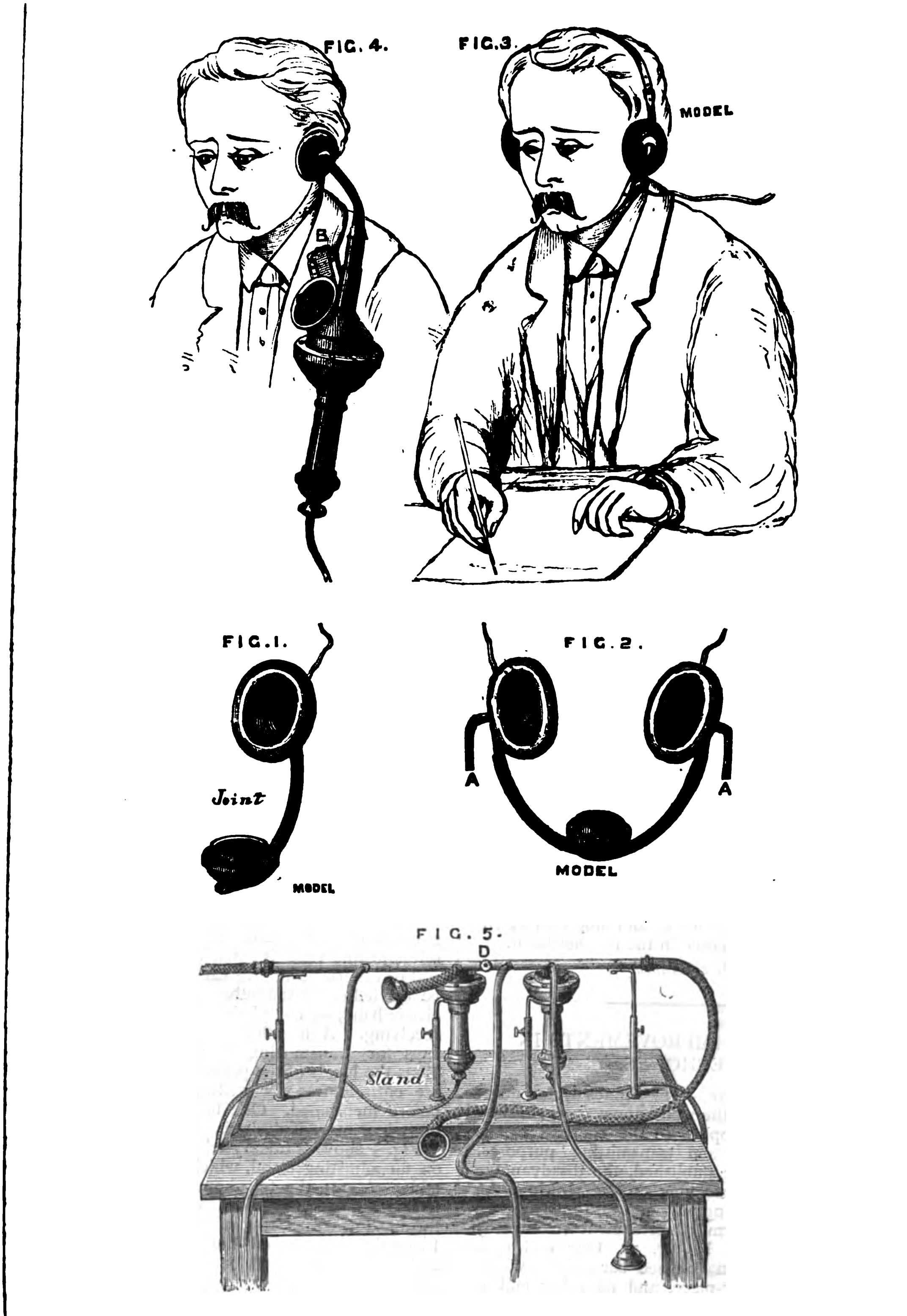


FIG. 4.
B
FIG. 3.
MODEL
FIG. 1.
Joint
MODEL
FIG. 2.
A
A
MODEL
FIG. 5.
D
Stand

Singing, music, &c., could be heard by many persons simultaneously. By the use of a valve or damper D in the hollow bar, one or more circuits can be brought into operation, both for receiving and transmitting purposes. Many serviceable uses can be made of this appliance. The remark applies equally to the other figures. The arrangements for padding the ear-pieces must not be lost sight of, as their use deadens general sounds, and much assists the receiver. These pads are built up of layers of thin gutta percha and cloth. Compared with the telephones now in common use, the new models are certainly much more handy, and will greatly facilitate accuracy of delivery and speed in transmission.

M. TROUVÉ'S NEW ELECTRO-MEDICAL APPARATUS.*

M. TROUVÉ has recently brought before the Société de Physique two current-interrupters, answering the same purpose though based upon different principles. The first, on account of its great precision, is intended more especially for physiological researches; it gives at each second of time the number of intermissions to the one-hundredth of a second, nearly.

The second, although not rivalling the former in precision, gives the number within about one-fifteenth of a second, which is more than sufficient for medical practice and is a result often sought after.

We know how important it is in practice to be able to regulate at will the number of intermissions. Hitherto, in ordinary medical practice we have been content with apparatus furnished with a Neef's trembler, by means of which it is possible to vary the number of intermissions within limits more or less wide, but without knowing the actual number.

Some physiologists, however, like Duchesne of Boulogne, foresaw the necessity of controlling the number of intermissions or successive passages of current for each second of time. Duchesne with this view arranged a pendulum whose balance marking half-seconds gave him either one interruption per second, or two, at will. The metronome and Masson wheel were also employed for the same purpose, but, as will be easily seen, the principal defects of these various systems were that they gave too restricted a field of variation, were too costly, and were not portable.

Dr. Onimus wishing to observe the influence of slow or rapid intermissions upon the movements of the heart and upon the muscular contractility in certain cases of paralysis, applied to M. Trouvé; and the following is a description of the portable apparatus they devised.

This induction apparatus (Fig. 1) consists of a primary coil independent of the secondary coils, a Trouvé "inversion" battery, various accessories for use in electro-therapeutics, and a special interrupter which is the principal part of the apparatus and forms the subject of this communication.

The interrupter (Fig. 2) is composed of a cylinder divided longitudinally into twenty parts; each section is furnished on the circumference with a certain number of stops or pegs, the number of which increases in arithmetical progression, *i.e.*, the first section has one; the second, two; the twentieth, twenty.

The cylinder is moved by a clockwork, the speed of which is regulated by a variable governor or fly, so that the desired number of turns per second can be given to the cylinder. A stylus can be shifted along the cylinder and so placed in contact with the different sets of stops, and thus the current be broken as many times as there are stops.

Suppose the stylus to occupy the first section, where there is but one stop; if the cylinder turns but once per second the current will be broken each second; and if it be made to occupy each section successively there will be 2, 3 . . . 20 interruptions per second.

Giving the cylinder a speed of 1, 2, 3, 4, 5, &c., turns per second, the number of stops will have to be multiplied by the number of turns, and thus is obtained with great precision any number of contacts from one to one hundred, and in a given time a given number of interruptions can be produced.

As during the rotation of the cylinder it would be impossible to read the divisions, and so to place the stylus at the right section, a small ivory scale, also divided into twenty parts, is placed parallel to the cylinder, and in connection with the stylus is a small pointer, which is brought over the section required to produce the number of breaks desired.

We must now explain how M. Trouvé succeeds in making the currents equal in duration, whatever the number, in a given time. This equality, in the duration of the current, is of special importance; without it one could not effect a comparison between results which varied with the variations of their sources.

For this purpose the style E (fig. 3) plays between two contacts, A B, of platinum, placed one over the other on a plate of ebonite. These contacts are put in circuit at will by means of a helical spring. It will be seen that if the upper contact B, is in the circuit, the current will be set up when the style is raised by a stop on the cylinder C, and will cease directly the stop is passed. Now, as all the stops have the same speed, and as the style and the spring D are invariable, it follows that the time of raising the style remains invariable whatever the number of contacts for each revolution. The same thing holds good for the duration of each current.

It is otherwise when the circuit is made through the contact A, for the current passes during the whole revolution of the cylinder if the style is placed over the first division, one second for example, whilst if placed over the twentieth division the duration of each current is only one-twentieth of a second. In a word, the duration varies with the number of intermissions, as is the case with ordinary interrupters. It follows from what we have said that in order to produce a succession of induced currents rigorously equal, which can only be attained with this apparatus, the circuit must be completed by contact B; if made through contact A, a constant current periodically interrupted on induced currents of variable duration may be attained.

The two binding screws, 1 and 2, are so arranged

* From *La Nature*.

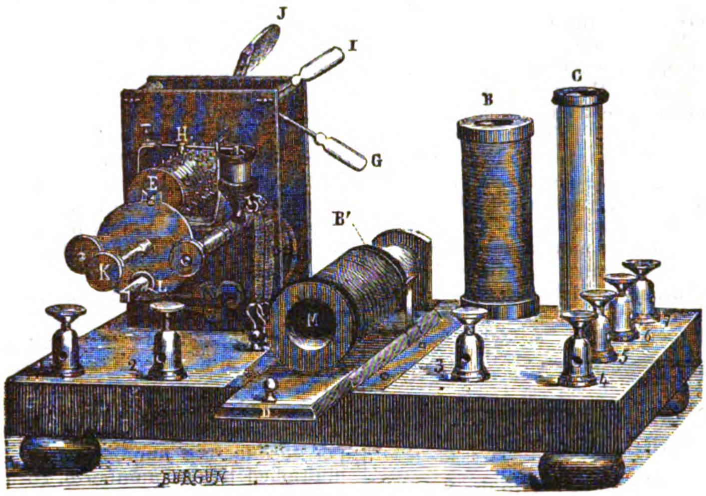


Fig. 1.

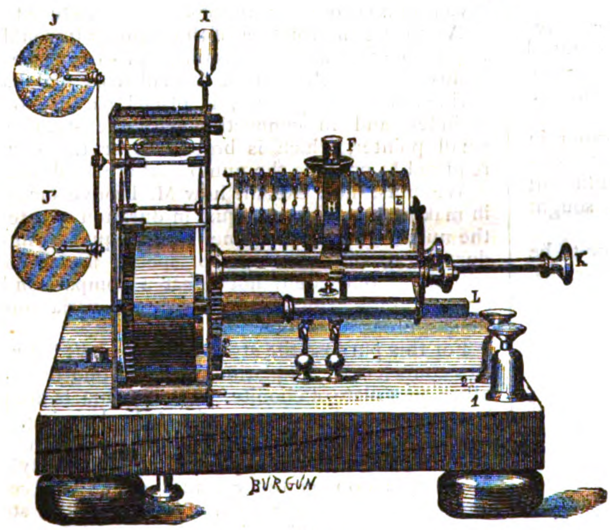


Fig. 2.

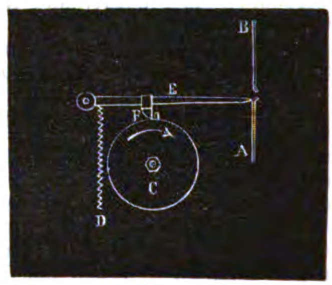


FIG. 3.

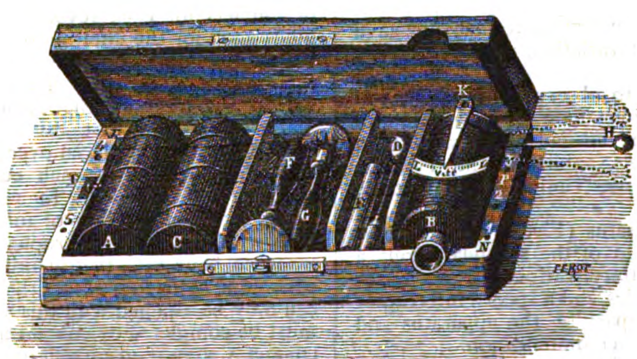


Fig. 4

as to place the patient and the interrupter in the circuit of a battery giving constant and continuous currents. It is only necessary to start the interrupter to produce the intermissions.

M. Trouvé uses this machine also to determine the proper number of vibrations to be made by the contact maker of any Ruhmkorff coil to give the maximum effect. In this case the contacts, instead of being made with the metal points A, B, are made in a mercury-cup, as in the Foucault interrupter.

If the figure (3) be examined closely it will be seen that the contacts of the style E with A, B, are sliding-contacts and are made tangentially, and that consequently the opening and closing of the current are made instantaneously and without variable pressures, conditions most favourable to the production of induced currents, and clean, well-defined muscular shocks.

The latter are obtained from terminals 5 and 6; from 6 and 7, the extra-currents; and from 5 and 7, both together. M. Trouvé wishing to endow the medical profession with an apparatus fulfilling the above conditions, but which should be within the reach of all as regards price and size, presented to the Academy of Medicine, through Professor Garrret, the apparatus we now proceed to describe (Fig. 4). The following is the note drawn up by the learned professor himself for the Academy's report, 5th June, 1877.

"M. Gararret presents, on behalf of M. Trouvé, a new induction apparatus intended for medical practice; this apparatus attains a considerable degree of perfection.

"It is highly important in therapeutics to be able to control the number of induced currents emitted. Hitherto but one machine has accomplished this end, viz., the regulator of MM. Trouvé and Onimus, which we have on a former occasion presented to the Academy. But this apparatus is very costly and can scarcely be employed elsewhere than in the physician's laboratory.

"By a very simple arrangement, M. Trouvé has constructed a regulator which enables the practitioner to vary at will and with great exactness the number of induced currents between 3 and 56 per second. This new regulator is very portable and easily handled; its price does not exceed 30 francs.

"It can also be employed in searching for bullets in gun-shot wounds. In practice, therefore, it may replace the large regulator of MM. Trouvé and Onimus, as also the electric wound-explorer of M. Trouvé, presented to the Academy in 1867."

This new apparatus is remarkable for the arrangement and simplicity of the interrupter, which in this case is of special construction, and in which its author has associated the law of the pendulum with the geometrical principle that a perpendicular is shorter than any oblique line. It comprises:—An armature mounted on a vertical pivot, on which metallic prolongations are affixed so as to considerably lessen the number of its oscillations, or to double or quadruple them, as will presently be seen.

A strip of platinum placed parallel to the armature like the usual contact spring in ordinary tremblers; this spring being in contact with the armature only at its free end, so as to bear no weight, forms with the armature the most sensitive trembler known; at the same time, the instrument is capable of bearing considerable rough usage without damage.

A vertical pivot placed a little beyond the centre of the trembler, and free to rotate on its axis half a circumference, carries at its upper extremity a needle moving over a graduated arc, and at its centre a platinum tooth, both pointing in the same direction. The latter can thus be made to occupy any desired position by being turned to the right or left. It will readily be seen that the more it is turned from a perpendicular to the trembler the greater will be the journey performed by the latter, and, consequently, the oscillations of greater duration. If it be turned parallel to the trembler no contact is made, and the apparatus is at rest. Placing the needle at the first graduation, where contact commences, the trembler armed with its lengthening pieces performs one oscillation or intermittance per second; at the second division, two oscillations, and so on, the numbers increasing until the tooth is at right angles.

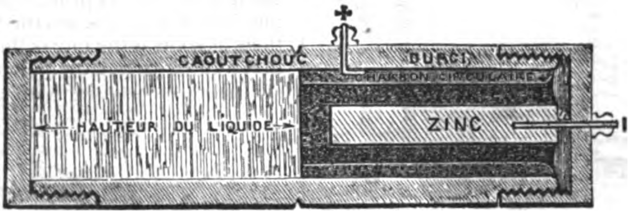


Fig. 5.

Removing the lengthening pieces, which have been adjusted to double and quadruple the time of an oscillation, the numbers shown on the arc are to be multiplied accordingly.

Intermittances of the following rates can thus be obtained: 1, 2, 3. . . . 10; 2, 4, 6. . . . 20; 4, 8, 12. . . . 40.

The figures inscribed on the graduated limb are previously determined experimentally by M. Trouvé by means of a small chronograph and registering apparatus, specially constructed for this purpose.

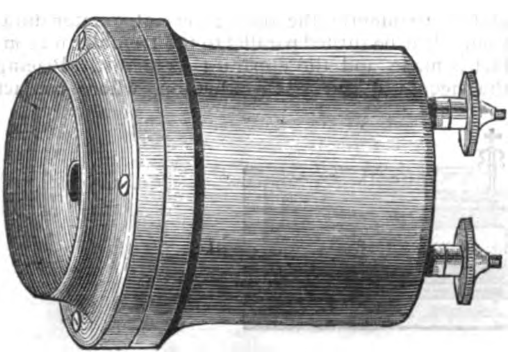
The service capable of being rendered to experimental physiology by the two sets of apparatus above described is self-evident; precision and method are imported into the application of the current; the number of intermissions necessary to produce tetanus of each muscle, stoppage of the heart, &c., can be instantaneously determined. They also enable the synchronism to be established between intermittence of currents and the normal physiological functions of the principal organs of animal life, the heart, lungs, &c., so that in cases of asphyxia the best effects may be obtained.

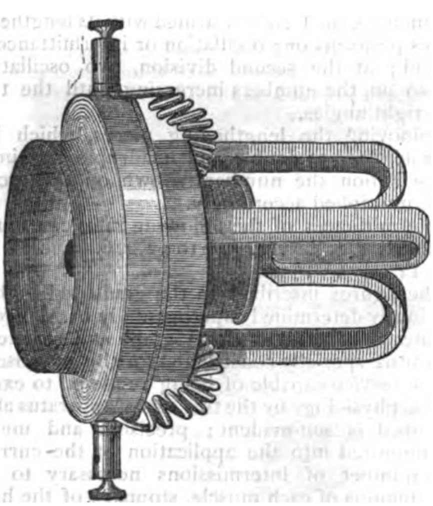
MM. Legros and Onimus, in their work entitled

Traite d'électricité Médicale, after pointing out that in certain phenomena of the heart and respiratory organs rapid intermittence is more prejudicial than intensity of current, suggest that if the happy idea of Hallé and Sue, of placing electrical apparatus at stations for the assistance of the drowned were carried out, apparatus of the nature of those here described should be employed; for by limiting the number of possible intermittences, they could be employed without danger even by unskilled hands.

HICKLEY'S TELEPHONE.

In the Telegraphic Journal for October 1, we illustrated the American "Crown Telephone" of Mr. Phelps; a form which appears to have been independently and priorly invented in England by Mr. Hickley, a mechanician. From the accompanying diagrams it will be seen that the principle is th



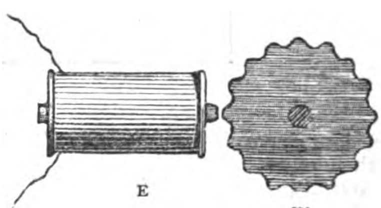


same in both of these instruments. Phelp's being a double form of Hickley's, one set of the like poles of the magnets centres on the soft iron pole piece being inserted in the coil and the other set connected to the soft iron diaphragm. The articulation is strong and distinct, although the instrument is small, as will be seen from the figures which are full-size. Larger forms are also sold. Messrs. M. Jackson and Co., Manufacturers of Scientific Apparatus, Barbican, are the sellers of Hickley's Patent Telephone.

THE PHONIC WHEEL OF M. PAUL DE LA COUR.

The most simple form of the phonic wheel is that shown by the figure. It consists of a toothed wheel of soft iron turning around an axis, so that the teeth pass very close, but without touching, to the pole of an electro-magnet. If a phono-electric current—that is, a current of which the force is a periodic function of time—is caused to pass through the electro-magnet, so that the pole exerts a periodic series of attractions on the tooth nearest to it, then the wheel will be in stable equilibrium not only when it is at rest, but also *when it turns at certain definite speeds*. This is particularly the case when one magnetic pulse succeeds the foregoing one in the time that the circumference of the wheel has turned a distance equal to one tooth.

If a series of pulsations, obtained by means of a tuning-fork provided with a make and break arrangement on one of its prongs, be caused to pass through the electro-magnet E and the wheel W be set in motion, then, as soon as the rate of this rotation becomes such that a tooth passes the pole of the magnet at each



pulsation, the motion will continue, and will be uniform as long as the pulsations pass through the magnet.

If the wheel, whilst in a state of motion, has a tendency given it to accelerate or retard its motion, such, for instance, as would be given it by a weight attached to a cord wound round its axle, then if this retarding or accelerating force does not exceed a certain limit, the rate of rotation will not be altered. The reason of this is that when the wheel tends to be accelerated in its motion, the teeth tend to pass beyond the pole of the magnet at the moment a pulsation is being transmitted through the latter, but when this is the case a direct backward pull will be exerted on the teeth as they pass beyond the pole, and so the acceleration is retarded and the speed continued uniform. If the force acting on the wheel is such as to retard its motion, then the action of the magnet will evidently be such as to give a direct forward pull to each tooth. M. Paul la Cour has succeeded in causing a phonic wheel to maintain its uniform rate of rotation when acted upon by an accelerating or retarding force of one

kilogramme-metre-minute. This property of the phonic wheel would render it useful for several purposes. Thus, by means of such a wheel, the synchronous uniform motion of clockwork trains, such as is required for astronomical purposes, and also for several forms of telegraphic apparatus, could be obtained with great facility.

By attaching a phonic wheel to an indicator, which would enable its rate of rotation to be ascertained, and by providing any sonorous body, whose rate of vibration is required, with a contact arrangement in circuit with the electro magnet of the wheel and a battery, the rate at which this body vibrates can evidently be readily ascertained.

Besides the regular motion—that is, the motion when one tooth passes the pole of the magnet for each magnetic pulsation—the phonic wheel will turn with a uniform motion at certain other rates; thus it will keep in uniform motion when the velocity is such that one tooth passes the pole of the magnet for every two magnetic pulsations. Again, the uniform motion may be obtained when the rate of rotation is $\frac{2}{3}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$ that of the regular motion. The power of the wheel to resist external forces is not so great under such conditions as it is in the case of regular motion. The case is the same if the rate of rotation is greater than the regular motion.

ELECTRIC LIGHTING.

Gas *versus* Steam Engines.—It is significant of the set which public opinion has now taken on the subject of gas *v.* electric lighting, that the Gas Light and Coke Company have decided to apply to Parliament, merely for powers to enable the Company to supply gas and apparatus for heating, cooking, ventilating and other purposes, and not for powers to adopt the electric light. The fact may be taken as an indication that the gas companies have come to the conclusion that the electric light, though taking the larger illumination out of their hands, will not seriously affect the vast and more remunerative field of domestic lighting; and that therefore they need not strain themselves to take up the electric light, but will be more profitably occupied in developing the resources of gas now in their possession, so as to better its quality, and extend its sphere of usefulness, even to the point of making it minister to the electric light itself. That the Chartered Gas Company has not taken this course without first studying the question was evident, from the exhibition of the Siemens' electric light, driven by a gas engine, which took place recently at the Company's Offices, Horseferry Road, Westminster. One object of this exhibition was evidently to display the advantages of the gas engine as a motor for dynamo-electric machines over the steam engine. Mr. Sugg, the well-known gas engineer, there pointed out that whereas it took an hour to get up steam in a steam engine, in the gas engine the power was obtained as soon as the gas was turned on. In the case of a sudden fog, therefore, or on any occasion when the light was required for a short time only, the gas engine would be suitable but the steam engine would not. The gas engine further possesses the advantage of accomodating itself to any variation in the external resistance, whereas the governor of a steam engine is too slow for such a purpose in relation to the electric light. In using the gas engine for lighting a large space such as Billingsgate Market, Mr. Sugg proposed to have five 8 horse-power engines, each of which would drive two dynamo-electric machines, placed at any convenient distance apart not exceeding 300 yards, the engine being in the middle. But as no attempt is here made to subdivide the current, we must consider Mr. Sugg's scheme as of very little real value, except from the gas maker's point of view. As to the cost of electric lighting by the Otto silent gas engine, Mr. Sugg stated that the gas consumed, if burned in sutiable Argand burners, would yield a light equivalent to 1600 sperm candles, whereas the two electric lights obtained therefrom by Siemens' system would amount to from 3000 to 4000 sperm candles; but as the latter had to be reduced from 50 to 60 per cent. by glass shades, the effective light in both cases was about the same. Now, the Siemens' machine employed to give this light would cost £70, and the two Siemens' lamps £40, while the 8 horse-power gas engine would cost £260, making a total of £370. The carbons would cost 1d. per inch, and consume at the rate of four inches per hour per lamp. one attendant would suffice. Mr. Sugg then showed his visitors a comparison between the electric light and a 200 candle gas burner, from which he deduced that the electric light was three or four times as expensive, a result strongly at variance with other data.

Edison's Light.—According to the *Times* New York correspondent, Edison subdivides the electric light by a main outgoing and returning wire of large size, connected by branch circuits, in which the lamps are placed. He means to find out the defects of this plan by a practical trial on a large scale at Menlo Park, and he is now fitting up two 80 horse-power steam engines, machines, and lamps for the lighting of that village. His chief secret, however, is in the lamp, and the light can be turned up or down like gas. He is not positive as to the cost, but is confident it will be cheaper than gas in the United States, by from 2.25 to 4 dollars per 1,000 feet.

Sawyer's Light.—Mr. Sawyer's domestic carbon light is enclosed in glass tubes 7 inch high and $1\frac{1}{2}$ inch bulbous at the top, and filled with nitrogen and other gases. The carbon is 1 inch long by 1-16th inch diameter, held between thick carbon bars. The carbon is heated to 50,000° Fah., (?) and the heat generated within the tube is carried off by a thick coil of metal to a copper plate, and thence radiated into the air. The heat of the tube, however, only makes it feel warm to the touch. The mode of distribution is the same as Edison's, and the flow of the current is regulated by a secret appliance. Each lamp is equal to four gas jets or (in New York) to 75 candles. The resistance of his carbon burner is much greater than a platinum one, and Mr. Sawyer does not think he can light more than 30 lamps with a 4 horse-power generating machine. The light has been taken up by the Electro-Dynamic Light Company of New York, and a public trial is forthcoming, the Hockhausen machine, which is said to be a trifle more powerful than the Wallace-Farmer, is to be used. The 30 lamps will produce a light equal to 2,925 candles, at an expense of 35 cents an hour as compared with 1.68 dollars for the same in gaslight. Mr. Sawyer claims that his carbons are indestructible, and that one of his lamps has been lit for a month. The light can be moderated at will from a feeble glow to six times the intensity of the ordinary gas jet. A suitable current meter has been devised.

Cost of the Jablochkoff Candle.—Messrs. Wells & Co., have published the following details of the cost of their mode of lighting by Jablochkoff's candle in London. There are at present three kinds of dynamo-electric machines used with this process, viz., the four-light, six-light, and sixteen to twenty-light Gramme.

These machines can be driven by an expenditure of one horse-power per light; and the maintenance of an Otto gas engine for this purpose would be from 1d. to 1½d. per horse-power per hour, attendance not included. For a four-light machine the estimate is as follows (exclusive of brackets):—

	£	s.	d.
Price of machine in London	180	0	0
Price of each lamp with globe, sockets, &c.	10	0	0
Insulated leading wire, per yard	0	2	0
A four horse-power (nominal) steam-engine with boiler, exclusive of shaft and fixing, about	140	0	0
A four horse-power gas-engine	175	0	0

Probably the whole cost of providing a four-light apparatus, including engines, brackets, and the services of a skilled engineer for a short time, to give intructions in its use, would amount to about £400; but a special estimate is in all cases necessary. The cost of the candles is 8d. each (lasting one and a half hours) or 5½d. per hour. In calculating the total cost of the light as compared with gaslight, an allowance for interest on capital, and about 10 per cent. for depreciation, must be made, but it is obvious that a similar allowance for depreciation should be made in respect to gas fittings.

Cost of the Werdermann Lights.—From a two horse-power Gramme machine Mr. Werdermann obtains a light of 320 candle power from a rod carbon 4 millimetres thick. This light can, we believe, be installed for £75. Each carbon can be procured a yard long, costs one franc, and will last from 12 to 15 hours.

Correspondence.

SOURCE OF SOUND IN THE TELEPHONE.

To the Editor of The Telegraphic Journal.

Sir,—I have seen with pleasure in the last number of your Journal that Mr. Fleeming Jenkin is of the same opinion with myself on the theory of the telephone, and that he has shown, as I have also done, that the effects produced in this marvellous instrument are much more complex than was believed at first, and that he maintains this in spite of the most evident proofs of certain *savants* who keep always to the classic science of the commencement of the century, and who do not believe it to be susceptible of progress.

I must remark, however, that Mr. Fleeming Jenkin, in speaking of *two* voices being heard in the telephone, that of the magnet being the feeblest, reasons as if the two effects were distinct, and not the result of effects of magnetic increase determined at the end of the magnet by the action of the diaphragm. These effects of increase are considerable since the magnetic force increases and multiplies itself. For the most feeble sounds from the bar magnet take place when it acts alone, and they are most strong if they can be heard separately from those of the diaphragm.

As to the sounds from the diaphragm itself, I have always believed that although they may result from the effects of magnetization and demagnetization, determined by the magnetic variations of the magnet, they may equally result from attractive effects at the moment these effects are produced, which evidently take place when voltaic currents are employed; but I have always believed, and still believe, that with the feeble currents which are produced in the ordinary Bell telephones, these attractive effects are *nil*, and the sounds produced are due to an effect analogous to that which takes place in the magnet itself. The sounds produced by the wire on the bobbins, which Mr. Fleeming Jenkin considers as added to those in question, have been already pointed out by M. Rosseti, and considered by M. Luvini to add to the reproduction of the sounds in the telephone. M. Luvini has even given them as completing my theory, and I am glad to see that Mr. Fleeming Jenkin still further agrees with us upon this question.

As to the fourth source of sound that this *savant* has observed, I agree entirely with him, although I have not made any experiments in this direction, but his reasons appear rational.

Accept, Sir, the assurances, etc.,

M. DU MONCEL.

Paris, Nov. 10, 1878.

To the Editor of The Telegraphic Journal.

Sir,—Will you allow me to correct your otherwise accurate notice of my case which appeared in the last number of your journal. You state that Sir William Thomson and Professor Fleeming Jenkin tried my telegraph instruments, and that *after* I expressed my "dissatisfaction with this trial, alleging that the referees did not keep to the terms agreed upon, a further trial was *suggested by Mr. Jenkin.*" This is an error. The letter of reference set forth "that any fault of detail was to be reported to me to give me an opportunity of overcoming it before a final report was made." Hence what followed, which I will extract from a letter sent by my solicitors to the Post Office, but which has never received any attention:—

"On 26th July, 1872, Professor Jenkin made a preliminary report addressed to both parties to the reference, which contains this passage:—

"'It is very desirable that an automatic Wheatstone's sender should be arranged to send slips with actual messages, so that they may be recorded by Mr. Herring's instrument. No trials can be quite satisfactory which do not exclude the imperfections of sending.'

"We find among the papers in this case the following minute:—

"'Nov. 18, 1872. Write to Mr. Fleeming Jenkin with reference to his preliminary report on Mr. Herring's telegraph instrument, and request to be informed whether he is still of opinion that the department should make, at its own cost, an automatic sender for the purpose of further testing Mr. Herring's instrument. F. I. S.'

"We also find that Professor Jenkin wrote to Mr. Scudamore as follows:

"'In answer to your letter of the 18th, I beg leave to say that I think it unnecessary that an automatic sender should be made by the department unless the officers of the department think it desirable.'

"This letter of Professor Jenkin is manifestly inconsistent with the rules which govern the conduct of referees, and with the ordinary principles of justice, and it is necessarily fatal to the assumption of 'a full and fair trial' which you would draw from the names of the referees. It comes to this, that one of the referees writes to one of the parties to the reference to inquire whether that party thinks it 'desirable' that a step should be taken which the referee had previously declared 'very desirable' for a satisfactory trial. In effect, the referee applies to one of the parties for directions as to the method of proceeding in the reference.

"A reference thus conducted would be an absurdity, and its result must be nugatory, and accordingly we find that Mr. Scudamore was sensible at the time that something more would be necessary to a satisfactory trial.

"On 19th December, 1872—

"'Mr. Scudamore promised that if Mr. Herring wished a further trial of the instrument after Messrs. Thomson and Jenkin had made their report he would give his consent.'

"We have before us Mr. Herring's memorandum of his interview with Mr. Scudamore on that day, and Mr. Scudamore's letter of the next day, admitting that that memorandum 'is accurate as far as it goes.'"

From this point the department has habitually broken its promises. It has never asked the referees to meet, although it induced me to engage and to pay two eminent scientific men to meet Sir William Thomson and Mr. Jenkin at the proposed trial. It obtained possession of my instruments, however, by a written assurance that it intended to proceed with the trial. It has never assigned any reason for thus acting, nor has it replied to my application to be reimbursed for the consequent loss of my time and money. It has even neglected to deal with my petition for redress, although such petition has been referred to it by the Sovereign.

I am, Sir, your obedient servant,
RICHARD HERRING.

27, St. Mary's Road, Canonbury,
November 10th, 1878.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—In your issue of 1st inst., Mr. Fahie observes "the values of A and B were wrongly given on page 86, as 39 and 1461, instead of 40·78 and 1459·22. Taking these figures it will be seen that

$$\frac{A}{B} = \frac{33·33}{1192·83} = \frac{40·78}{1459·22}$$

the error here is therefore only apparent."

Now

$$\frac{33}{1192·83} = 0·0279 = \frac{40·78}{1459·22}$$

and the error is *only apparent*, but

$$\frac{39}{1461} = 0·0266,$$

and therefore that discrepancy which I pointed out, although slight, did exist.

I am glad to find from Mr. Fahie's explanation that he was quite correct about the "strength of the *signal*," which I confused with the "strength of the *current*." It It is a pity Mr. Fahie did not show by figures how his results were obtained. To be strictly correct, the total resistance in circuit in such instance must be taken into consideration. With A and B = 39 and 1461 respectively, which values are more convenient for calculation, it will be found that (1) when both keys are at rest currents through each relay may be represented by 138.

(2) When one key is depressed
Current through relay of same station = 136
" " " other " = 83

(3) When both keys are depressed
Current through each relay = 80.

Mr. Fahie declares that duplex working would be impossible if the current in the home relay were reduced where the key is depressed. This is not the case, for it is only necessary to adjust the relay, so that this current shall not work it, but that any still weaker current shall.

I am, Sir, yours truly,
H. A. W. FANSHAWE.

16th November, 1878.

Notes.

THE TELEPHONE.—M. Bosscha, a German physicist, finds that the plate of a Bell telephone has a bodily motion under the influence of the sonorous currents, a result which agrees with that obtained by the research of Prof. Hughes, which we give on another page. M. Bosscha measures the displacement of the centre of the plate to be 34·3 thousands of a millimetre for a current of one weber strength. The least displacement of the plate which is capable of yielding audible sounds is 2·5 thousands of a millimetre or about $\frac{1}{100}$ of the wave length of yellow light.

EDISON'S carbon telephone was recently tried between London and Norwich on a circuit very noisy with the induced currents from busy lines alongside; but conversation was carried on successfully when the voice was lowered a little below the ordinary tone.

EDISON states that he has invented a non-magnetic telephone receiver which gives out sounds as loud as the original ones or even louder.

Apropos of the announcement that Edison's carbon telephone had been recently tried successfully over a line 750 miles long, Mr. A. Scott states in the *Times* that Mr. Willoughby Smith obtained distinct results with Bell's telephone through a resistance equivalent to 125,000 miles of telegraph line. This is an interesting fact in itself, but laboratory resistance should not be compared in this way with actual telegraph lines.

THE Microphone has been successfully employed as a thief-catcher by an Indian officer, who suspected some of his coolies of oil stealing. A microphone among the oil jars enabled him by a telephone to hear the marauder at work, and to capture him in the act of filching the oil.

WE have seen and heard a receiving microphone belonging to Prof. Hughes which gives very striking effects. The voice heard from it is so natural and like the speaker's, that we at first believed we were overhearing the speaker, until assured of the contrary by withdrawing the little instrument from the ear. The peculiar timbre of telephone plates is entirely absent from its tones. This microphone was a hammer and anvil form *made of pointed pieces of crystalline coke* and fixed on the diaphragm of a small tambour.

THE ELECTRIC LIGHT.—We have received the prospectus of the British Electric Light Company, Limited, formed for the purpose of supplying the electric light as an illuminator or for applying electricity for other purposes. The capital is £100,000, divided into 10,000 shares of £10 each, and the liability of shareholders is limited to the amount of their shares. The first issue will consist of 4,000 shares, and it is not intended to offer the shares to the general public. The first object of the Company is to acquire an exclusive license for the United Kingdom, under Gramme's patent, for producing electric currents, and an arrangement will be made for the purpose with Messrs. Ball & Co., Limited (the sole agents for Grammes' machines hitherto in England). The first outlay of the company will comprise the purchase money for the license (exclusive of a royalty on each machine), and the compensation to Ball & Co., for relinquishing their agency, making a total of £14,250. To this sum must be added the legal and

other expenses necessary for the formation of a company. Among the names associated with this company we notice Mr. E. J. Reed, C.B., Mr. Latimer Clark, and Sir Charles Bright. The electrical engineer is M. Radcliffe Ward, and the London office is in Broadway Chambers.

We have also received the prospectus of the National Electric Light Corporation, Limited. The primary object of this Company is to supply the Rapieff Electric Light. The capital is £500,000 divided into 50,000 shares of £10 each, and the first issue will consist of 25,000 shares. The liability of shareholders is limited to the amount of their shares. The Company intend working the patents of M. John Rapieff, and any improvements thereon, or other inventions for a like purpose, and they also include other applications of electricity besides lighting, within their scope. According to the contracts entered into, M. Rapieff has received from the Company £25,000 and 5,000 fully paid-up shares for his patent. Mr. A. J. Otway, M.P., director of the Submarine Telegraph Company, is Chairman of the Board of Directors, and Mr. E. J. Reed, C.B., will join the board on his return from Japan. The manager is Mr. Applegarth, C.E., and the electricians are M. John Rapieff, and M. Alexander Lineff, *assistant*.

The Sun Electric Light Company have acquired several patents, one of which is for a flexible carbon wick, the advantage of which is that a length of it can be stowed in the lamp and manipulated like an ordinary wick.

A regular course of telegraphic engineering studies has been established this session at University College, London.

The Telegraphic Museum, established by M. Stephan, the director of German telegraphs, has been opened to the public in Berlin. It is comprised in two large halls of the General Post Office there.

Divisibility of the Electric Light.—In a series of communications to our contemporary, *Engineering*, Professor S. P. Thomson, of Bristol, deduces from dynamical principles, "that any system of subdividing the light by branching the circuit, is disastrous from an economical point of view: because, when the external resistance of the circuit is thus diminished, the increased relative amount of unavoidable internal resistance causes a waste of energy which more than balances the 'dynamic economy' of having in the arc so large a percentage of rays which can affect the eye." This waste of energy takes the form of heat within the battery or other source. Experiments on the resistance of the larger electric arcs, given by Lontin, Rapieff, and Werdermann's systems, with currents of different strengths from dynamo-electric machines, together with estimates of the relative intensities of the light, are at present a great desideratum. The results of Professors Ayrton and Perry are an interesting contribution to this subject, but they were obtained by the use of a battery, not a dynamo-machine, and their chief merit lies in pointing out that the larger researches we have indicated are required.

The Liverpool Corporation have decided to apply to Parliament next Session, for powers to light Liverpool and other places within their rule, by means of electricity. They also desire the right of taking over the works of the existing gas companies, and extending the supply of gas for gas engines and cooking purposes.

The central transept of the Crystal Palace is being lighted by the Sun Electric Light Company. A small Gramme machine, driven by a 12 horse-power semi-portable Ruston and Proctor steam engine, is employed to yield the current; and the lamps are to be on Harrison's plan.

The Liverpool Street Railway Station is to be lighted by Wallace-Farmer electric lights, each enclosed in clear glass globes, and elevated 20 feet above the platforms. When the electric light is well elevated, it should be provided with a reflector to throw the radiance down, otherwise much of it is lost in the upper air.

The Alexandra Dock Company of New Port, South Wales, have decided to use the electric light to illuminate part of their docks, in order to carry on their coal shipments with greater ease by night.

At the Royal Academy on November 21, Professor Barff lectured on the kinds of light best suited to the lighting of studios and picture galleries. He illustrated his lecture with the electric light, in whose favour he decided.

An Electric Light Company, to produce light, heat, and power, has been formed in New York, with a capital of 300,000 dollars. Mr. Edison is one of the promotors.

Football matches and political speeches, by electric light, continue to come off; and many different kinds of manufactories are being provided with it. The large tobacco factory of Messrs. Cope Bros. and Co., Liverpool, has been lit by Jablochkoff's candles. In his speech at the celebration of the event, Mr. Maccabe (another theatrical manager who has been attracted by the electric light) rather aptly said, that what the public wanted was to get electric candles at the same price as ordinary dips, and to light them up as easily. It is in the cigar room where several hundred females are employed making cigars, that the chief advantage of the light will be felt. It will render the room brighter and cooler, and make it possible to select the tobacco leaves according to their varieties of shade and fineness.

The long-expected trial of Jablochkoff's system at Billingsgate has come off, and some of the fish dealers were disappointed with it. A greater effect would have been obtained by having more lamps than 16 to replace 700 gas jets.

It is said that Sir William Armstrong and Co., at their Elswick Works, Newcastle, are making a large engine for use in connection with the Edison electric light. Sir William has also lit his picture gallery at Craigside, his estate near Newcastle-on-Tyne, by a Siemens' lamp. The current is obtained from a Siemens' machine and turbine, placed at the source of power, a waterfall one and a half miles from the house. Generated at the fall, the current is conveyed all that distance in an underground cable, and it has been found necessary to employ a return wire. By means of an electric motor, Sir William also intends to apply the electric energy to sundry domestic purposes.

The famous engineer, M. Krupp, has introduced an electric lamp of his own construction at his steel works, Essen, in Prussia. The regularity of the current is maintained by a fan revolving in mercury, and the carbons are arranged vertically one over the other.

The light is said to be one-third cheaper than gas light, which there costs about the same as it does here.

One of the ingenious notions which seem to enrich even the commonest talk of Mr. Edison, is that of having hand electric lights which can be moved about, the current being conveyed to the wick along wires enclosed in a flexible cord. In this electric cresset there will be neither oil nor dripping, but probably tripping.

We are somewhat surprised that the gas critics of the electric light have not put forward the belief that the wire for the electric lights will be a source of danger to the community by "attracting" lightning strokes into every house. Nor does it seem to have occurred to electricians themselves that some kind of domestic lightning protector may be necessary to guard the circuits. Current meters and lightning protectors are subsidiary inventions which will be required.

A notable suggestion is made by "Photophilus" in the *Photographic News*. It is to light the reading-room, and, perhaps also the library, of the British museum by the electric light. Owing to the destructive effects of oil and gas lighting on books, and the danger of fire, the reading-room is not opened after dark, thus preventing students from using the library after their working hours in winter, the reading season. It appears to us that Mr. Werdermann's system is well adapted for the purpose. Until Mr. Edison's plan is publicly exhibited there may be a certain reluctance to take up other systems, although Mr. Werdermann's is well suited to light both the British Museum and the Albert Hall.

Diffusing Light by Steam.—The powers of condensed steam for diffusing light by reflection and emission after absorption, are well seen in the case of clouds and locomotives, and Herr Brandau, of Berlin, has patented a means of using it for artificial lighting. The steam passes through a glass globe exposed to the beams of the light source and diffuses a uniform brightness. As a reflector for the electric light, this may prove useful. The white cloth reflector employed by Messrs. Siemens' Bros., answers the same purpose.

Prof. S. P. Thomson will lecture on the Electric Light, before the working men of Bristol, on December 13. Over 2,600 people attended his former lecture in the Colston Hall there. A fine opportunity for making a brilliant hit by lecturing on the subject awaits some of our electric expositors in London. Will not Prof. Tyndall, or Mr. W. H. Preece, or Prof. Barrett, favour us with a Royal Institution or South Kensington address on this important subject early this winter? There has been no dearth of electric sensations of late; but it must be admitted that the electric light is the most splendid of all the themes which Electricity can put into the hands of the scientific lecturer.

The following poetical trill is from the *Journal of Gas Lighting*:—

"Pity the poor deluded,
On share-selling madly bent.
Laugh at the dupes denuded
Of interest 10 per cent.
Envy the fortunate buyers,
Free from panic and fright;
Honour the bold defiers
Of Blinding Electric Light."

Our versatile poet asks us in the same breath "to pity," and "to laugh" at the deluded shareholders. We are more inclined to keep these emotions for the bard himself.

The Glow-worms and the Fire-flies—A Fable.—Once upon a time there was a colony of glow-worms who lived in a very dark wood; and the other small denizens of the wood, finding that they had such excellent lamps in their tails, were only too happy to let them form into a company to light up the recesses of the grove at night, and to pay them for their light. Only the night-hunting moth and the blind mole objected to such a course, so the glow-worms united themselves into a corporation and waxed fat on the taxes they levied for their light. But as they waxed fat, they found it more and more trouble to keep their tail-lights bright; nor did they wish to, for they were paid whether their lights were good or bad, and if a poor grub complained that he could hardly see to dig, they would straightway cut off his light altogether. At length this oppression became very irksome to the community, and one day a grasshopper, who managed a company of performing ants, and required a good light for his theatre, brought over a fire-fly from a neighbouring garden and placed him in the midst of the lazy glow-worms. The brilliant light of the fire-fly quite cast the dingy glow-worms into the shade; but these bloated maggots only shrugged their shoulders, and said, "That's only one—and see how bright it is, it will blind you all," then went to sleep again. Nevertheless, more and more fire-flies came to the wood from the garden, and the glow-worms began to quicken up and get afraid that after all there might be something dangerous to them in these new lights. Things were in this state, when, one fine day, a gad-fly, an arrant gossip, and post-boy to the grove, suddenly brought the news that the "Great American Lightning Bug" was coming. The effect was indeed electrical—one half of the frightened glow-worms scampered off as fast as their legs would carry them, and the other half turned over on their backs and grew sick. But time passed and the Lightning Bug did not appear, so the glow-worms gradually took heart again and those that had run away came back, while those that had turned ill recovered their dignity, and all of them boasted as before. The gad-fly was denounced as a rogue, and the Lightning Bug was proved to be only a large Hum Bug, but for all that the fire-flies continue to arrive faster than ever, and the gad-fly swears that the Lightning Bug is on his way.—*Will o' the Wisp*.

Submarine Quadruplex.—Dr. Alexander Muirhead, together with Mr. G. Kift Winter, the inventor of the closed circuit duplex system in use in India, and Mr. J. A Briggs, have invented improvements in duplex and quadruplex telegraphy, whereby the latter system can be applied to submarine cables. The patent description was communicated from Madras, where Dr. Muirhead recently sojourned while duplexing the Madras to Penang Cable.

Submarine Duplex.—In reply to communication to the *Times* by Mr. Herring, Sir James Anderson states the Eastern Telegraph Company are now working Muirhead's duplex system on the Marseilles-Malta section (825 miles) at the rate of 26 words per minute, whereas by simplex they only attain 15 words per minute. The increase of speed on all the sections from Malta to Bombay is at least 70 per cent. With regard to land lines, Sir James says that on the company's line between London and Porthcurnow, a distance of 320 miles, as many as 54 words per minute can be sent as against 25 by simplex.

PROF. GRAHAM BELL is in America seeing to his patent case there.

MR. L. SCHWENDLER has returned to India.

THE INTERNATIONAL AGENCY OF ELECTRICITY.—We are glad to learn that this project approaches realisation. Count Hallez d'Arros now announces that the scheme has been well received by the French and foreign press, and that a great number of constructors have offered to put their apparatus in the electrical museum to be formed. We have already avowed our goodwill to the project, and our wish to further it, and we should like to see some of our electrical makers assist in the enterprise. It will probably be with the *Agence Internationale de l'électricité* as with other things, when it has shown that it can achieve success unaided, it will receive plenty of support from abroad. Let it first establish a French nucleus and foreign aid will gravitate to it.

IN the list of subjects set by the Institution of Civil Engineers for prize essays during next session, (1878—79) we observe the following: "Recent progress in telegraphy, with a notice of the theoretical and practical data on which that progress has been based;" "The application of electricity to lighting purposes, contrasted with the best systems of lighting at present in use;" and "The relative advantages of steam, heated air, gas, water, and electricity as the motive power in small engines."

AT the Society of Arts, John Street, Adelphi, a paper on "Electric Lighting" will be read by Mr. Shoolbred. The third course of Cantor lectures will be delivered by Mr. W. H. Preece, on "Recent Advances in Telegraphy," the first lecture being given in April, 1879.

WE hear that the Edison-Preece microphonic affair is to be brought before the Chicago Electrical Society with a view to its being cleared up.

ON an after January 1st, 1879, each word of a telegram between England and Germany will cost 30 pf., without any restrictions as to number of words, route, or locality.

THE Western Union Telegraph Company is again meeting with active rivalry in the Eastern States. The Central Union Telegraph is extending its Oswego and Syracuse line to New York, and is about to combine with the Continental Telegraph, which proposes to push out to the West as soon as possible. The tariff which the latter have adopted between New York and Philadelphia is 15 cents per message, although the charge over the Atlantic and Pacific line is only 10 cents. Notwithstanding this discrepancy, the Continental line is as busy as it can be, and three wires more are being erected.

OVERHEAD wires are to be abolished in Philadelphia and underground wires are to be adopted. Experiments have been made at the National Tube Works, McKeesport, with the patent insulated core of Mr. H. Alberger, which we noted on June 1st. Alberger's cable is formed by enclosing a copper conductor in a glass tube within an iron tube, and heating the whole to red heat. The combination is then passed between rollers, which solidify it without crushing it. The core is made in 10ft. lengths, with convex ends, so that in jointing the pieces the conductors will first touch. The iron exterior will be enamelled before being laid for the sake of durability. It will be seen from our list that this core has just been patented in England.

New Patents.

4528. "Telephony." H. J. HADDAN (communicated by G. Black and A. M. Rosebrugh). Dated Nov. 8.

4529. "Improvements in telephones and telephonic call mechanisms." H. J. HADDAN (communicated by A. M. Rosebrugh). Dated Nov. 8.

4553. "An improved mode of manufacturing carbons for electrical purposes." M. GRAY. Dated Nov. 9.

4559. "Improvements in the arrangement of mechanism to be employed in connection with apparatus for producing light and heat by means of electricity." C. DAVIS. Dated Nov. 11.

4568. "Electric light apparatus." J. MACKENZIE. Dated Nov. 11.

4573. "Improvements in apparatus chiefly designed for the electro-deposition of metals and the production of light by electricity." G. ZANNI. Dated Nov. 11.

4575. "Means or apparatus for electric lighting." H. W. TYLER. Dated Nov. 12.

4590. "Duplex and quadruplex telegraphy." J. Muirhead, Junr. (communicated by A. Muirhead, J. A. Briggs, and G. K. Winter). Dated Nov. 12.

4595. "Improved means and apparatus for generating electric currents and an improved electric lamp." C. F. HEINRICHS. Dated Nov. 13.

4601. "Improvements in telegraph cables, and an improved mode of manufacturing the same, parts of which improvements are applicable to other purposes." B. HUNT (communicated by M. H. Alberger and S. W. Petit). Dated Nov. 13.

4611. "Methods of an apparatus for producing electric light, heat, or motive power, by means of electricity." E. EDWARDS and A. NORMANDY. Dated Nov. 13.

4626. "Improvements in the means or apparatus for obtaining light by electricity, and distributing, regulating, and measuring the electric currents for the same." St. G. L. FOX. Dated Nov. 14.

4635. "Apparatus for dividing and distributing electric currents for lighting and other purposes." E. J. C. WELCH. Dated Nov. 15.

4645. "Improved means for obtaining electric light." J. S. LELLAR, W. LADD, H. EDMUNDS.

4646. "Electric lamps." J. S. LELLAR, W. LADD, H. EDMUNDS.

4662. "Improvements in producing the electric light and in lamps applicable to that and other sources of illumination." J. T. SPRAGUE. Dated Nov. 16.

4671. "Production, regulation, and distribution of electric and electro-calcic lights." W. L. SCOTT. Dated Nov. 18.

4686. "Improved means of transmitting electricity to great distances." E. U. PAROD. Dated Nov. 19.

4689. "Apparatus for producing the electric light." E. J. C. WELCH. Dated Nov. 19.

4690. "Improvements relating to electric regulators, lamps, or candles." J. H. JOHNSTON (communicated by A. de Méritens). Dated Nov. 19.

4693. "Dividing the electric light and apparatus therefor." A. RIEMENSCHNEIDER, F. S. CHRISTENSEN. Dated Nov. 19.

4696. "Electric telegraph insulators." C. E. CRIGHTON. Dated Nov. 19.

4705. "An improved method or system of distributing, dividing, regulating, controlling, and

measuring electric currents, in the practical application of the same to electric lighting and other useful purposes." J. F. CHEESBROUGH (communicated by W. E. Sawyer, and A. Man). Dated Nov. 19.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

656. "Lamp Signals." A. M. SILBER. Dated February 16, 1878. 2d. This consists in forming a lantern by which the light can be shrouded or displayed at will, by closing or opening hinged doors. *Void because complete specification not filed.*

717. "Electric Lamp." R. A. KIPLING. Dated February 21, 1878. 6d. This consists in forming an electric lamp of four carbons, two meeting at their points at one level, and two others also meeting at their points at a somewhat higher level, and crossing the lower pair at right angles. It will be seen that this lamp is similar to Rapieff's. For supplying fresh carbons, as those in the lamp become wasted, the casing containing each may be made like the cylinder of a revolver, having its chambers charged with carbons, a new carbon being brought into line as the old burns down. Tubular carbons are preferred as giving a more powerful arc.

719. "Galvanic Cells or Batteries." WILLIAM SPARKES WILSON. Dated February 21. 6d. This consists in forming cells of three compartments, the inner one containing the positive pole carbon, the mid one containing nitrate of soda, binoxide of manganese, &c., and the outer containing the negative element, zinc. A solution of sulphuric acid is employed as the liquid. Lumps of chalk are also placed in the outer compartment.

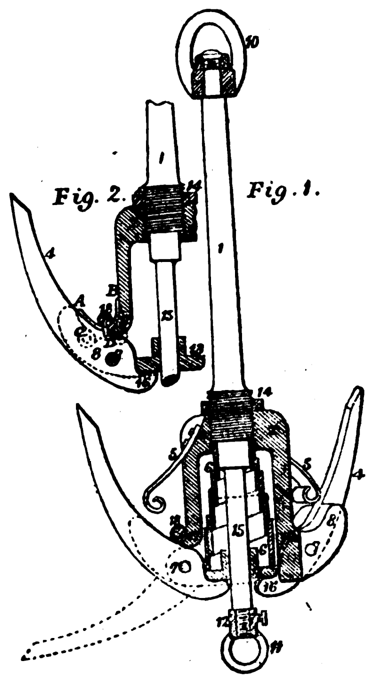
759. "Telegraph Cables." F. LAMBERT. Dated February 23, 1878. 6d. This consists in protecting cables from toredo ravages or rusting, by sheathing it in the material called mineral wool, slag wool, or silicate cotton, with a suitable agglutinating material such as pitch, tar, oils, india-rubber, &c., capable of resisting the action of water. The protection is applied either as an outer coating, or as a tape wound spirally round the core, or as serving in lieu of the ordinary hemp serving.

767. "Covering Telegraph Wires, &c." HENRY CONRADI (communicated by R. Wiebe, Wolgaste, Russia). Dated February 25, 1878. 2d. This consists in insulating wires, with a covering made from india-rubber or caoutchouc, dissolved by throwing bisulphuret of carbon (CS_2) over it, and is prepared in bottles with large necks, tightly stopped. The metals are sponged with this solution, and an hour after, they are sponged repeatedly with a second solution. This solution is made by taking gutta-percha, wool, tar, and rosin, and pouring bisulphuret of carbon over it, then mixing the result with the first india-rubber solution in the proportion of 4 to 1; then adding more bisulphuret of carbon. *Not proceeded with.*

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

AT the ordinary general meeting of this Society, Nov. 16th, Mr. ANDREW JAMIESON, C.E., read a Paper on "Cable Grappling and Cable Lifting." After reviewing the various kinds of accidents which produce faults in submarine cables, and classifying them into faults by abrasion, anchors, teredo, deterioration of core, and lightning, Mr. Jamieson described the process of grappling and lifting cables. He pointed out that the present mode of stoppering a cable when it has been raised up to the bows on the grapnel is unsatisfactory: a man having to be lowered to cut it with a saw: and also suggested that improvements might be made in lighting mark buoys. At present these buoys are lit by a lamp attached to the pole of the buoy by a boat's crew, a clumsy, and in rough weather, a dangerous mode. Captain Collison's buoy, which is lit by gas compressed to 10 atmospheres within the buoy itself, has been recently tried during gales at sea; and had kept alight for twenty-two days and nights; the light being visible four miles by the glass, and two by the naked eye. This buoy, Mr. Jamieson thought, was worthy of trial. It may be mentioned that in the discussion which followed the paper, Mr. W. H. Preece related that he had seen a buoy off Sandy Hook which compressed air as it rose and sank on the swell, and gave out a powerful whistle. Mr. Jamieson then came to the subject of grapnels, and after describing the ordinary grapnel, the centipede and Lambert grapnels, he gave a detailed account of the grapnel with hinged flukes, invented by himself and Mr. W. F. King. The



special advantage of this grapnel is that in moving over the bottom should the prongs or flukes encounter a rock, they will not be broken off as in the case of the ordinary and centipede grapnels, but will bend backward until they relieve themselves from the obstruction, when the grapnel is freed. On the other hand, should the cable be caught it will fall into the hollow between the stem and shorter flukes, where it will be retained. The figure represents a section through this form of grapnel, where 1 is the stem and 10 is the shackle; 2 is a hollow cast iron box, containing a stout spiral spring 6; 4, 4, are the moveable flukes, long and pointed, turning round pivots 7, 7; 8, 8 are the shorter flukes which retain the cable 18, when it is caught, although the longer flukes 4, 4, may be bent back. The flukes 4, 4,

are prevented from going back too far by a knuckle 16 on their inner ends. The springs 5, 5, are designed to help in retaining the cable on the shorter flukes, but we believe that in the newest forms of the instrument their use has been abandoned as unnecessary. The stem is screwed into the boss and jammed by the nut 14. By means of the ring and screw 11 and 12, a weight or drag chain can be attached to the bottom of the grapnel. A moveable washer or piston 13, caps the lower end of the spiral spring and acts as a buffer for it; the knuckles 16, on the inner ends of the flukes 4, 4, pressing on the buffer as they turn inwards, while the flukes are being bent outwards by the rock. As soon as the flukes have been turned sufficiently far back to escape the impediment, the force of the spring throws the flukes into their original position with respect to the stem. In figure 2 also, A and B are the blades of shears turning round fulcrum C and D, so that when the cable presses upon them the blades close on it and sever it. Mr. Jamieson does not fit these shears to the grapnel ordinarily, and in his communication to the society of Telegraphic Engineers, he did not describe them; but if successful in their operation, there are cases of cable grappling in which they might be serviceable. The merit claimed for Jamieson's grapnel is that it saves the expense of renewing the broken flukes of centipede grapnels. Sir Charles Bright, in the discussion which followed the paper, enquired of Mr. Jamieson its price as compared with the centipede grapnel. Mr. Jamieson replied that his grapnel cost £50, whereas the centipede cost from £10 to £15. Jamieson's grapnel has been successfully tried in practice both on the Brazilian and on the Eastern Telegraph Company's Cables.

PHYSICAL SOCIETY.

AT the meeting on Saturday the 9th November, Prof. G. C. FOSTER, Vice-President, and afterwards Prof. W. G. ADAMS, President, in the Chair.

The following candidate was elected a member of the society:—Sir Frederick Elliot.

Prof. W. G. ADAMS explained a simple appliance made by Mr. S. C. Tisley, for exhibiting the coloured bands due to interference with thick plates. The bands due to regular reflection and refraction were produced by two thick plates nearly parallel to each other, and fixed in a brass box with rectangular apertures on its flat faces so that the light fell on the first plate at an angle of 60°. The elliptical interference bands due to the scattering or diffusion of light at a point on the front surface of one of the plates, were shown by means of a precisely analogous arrangement, except that the inclinations of the plates to each other was somewhat greater; in this case, the interference bands formed by *regular* reflection and refraction fall in another direction, so that they are not received by the eye. Prof. Adams pointed out that this instrument would form a convenient means of obtaining polarized light in cases where the length of a Nicol's prism is objectionable.

Prof. BARRETT described and exhibited Edison's Micro-tasimeter, which we illustrated in our last number.

The carbon telephone, described in our issue of April 15th of this year, was then shewn, and its principle described. Prof. Barrett stated that according to Prescott's work on "The Telephone," the carbon telephone had been used successfully on the same wire, conveying quadruplex messages, and his own experience of the carbon telephone enabled him to state that the instrument worked, though feebly, when the line wire was broken, the fractured ends being near to but not touching each other. No other telegraphic instrument he had tried was able to transmit through such a circuit.

Mr. ADAMS, the assistant of Mr. Edison, was present at the Physical Society's meeting, and exhibited a complete transmitting apparatus, with call, &c.; and when he spoke to the carbon telephone in a distant part of the building, exclamations were audible to the entire meeting.

Mr. Edison has also recently invented a new form of receiver, more delicate than that employed in these experiments. No magnet is employed, and the volume of sound is largely increased.

M. LADD afterwards showed several forms of electric lamps, arranged so as to render clockwork unnecessary.

AT the ordinary general meeting of the society on Saturday, Nov. 23, Professor W. E. AYRTON read a Paper by himself and Prof. Perry, on "The music of Colour and Visible Motion." Prof. Ayrton, after alluding to the fact that in Japan and China the art of posturing and dumb show is cultivated to a high degree, producing emotions in the native auditors, which it fails to do in the Europeans, and seems to take the place there which our opera does here, went on to say that he believed that in the far distant future the western nations would cultivate this hitherto neglected side of their æsthetical natures, and develope a new emotional art. It was well known that moving bodies and changing colours produce an emotional effect on spectators. The eastern nations had cultivated this to a high degree, but the western nations had cultivated the emotional art of music instead. Professors Perry and Ayrton, in order to inaugurate a science of this new art had invented a machine which gave changing harmonic motions to a visible body, and varied the colours of the background against which it was seen. A drawing of this machine was exhibited. It consisted of a revolving barrel curiously cut so as to give certain movements to levers, which actuated the visible body. They claimed that this was the first machine of its kind, the first musical instrument of the new emotional art. A variety of such instruments could be designed to give a variety of effects; and it might be possible for a whole city to watch the fleeting display projected upon the clouds above them or upon a screen.

Dr. SCHUSTER also described his new method for adjusting the collimator of a spectroscope for parallel rays of different refrangibility, by looking through the telescope and turning the prism round. When only one focus is observed the collimator is properly adjusted.

General Science Columns.

THE ELEMENTS NOT ELEMENTARY.—Mr. Norman Lockyer, reasoning on the results of a long series of comparisons of the spectra of different elements, has arrived at the conclusion that the elements are really composite bodies. This has long been suspected by chemists, but Mr. Lockyer believes that he has proved it. His opinion is that all the elements are composed of one elementary substance—hydrogen—under different degrees of concentration. Thus the nebulæ being intensely hot, are formed solely of hydrogen, the sun being a body middling cool, contains many varieties of "elements," and the earth, a mass cooler still, contains a greater number of different materials still. Mr. Lockyer will shortly communicate his alleged discovery to the Royal Society.

"PHILLIPPIUM" is the name given to a new metal whose oxide was discovered by M. Delafontaine. It has been discovered in the mineral gadolinite, in which the reported new metal mosandrum was found. It will be remembered that M. Delafontaine questioned the existence of mosandrum, and judged it to be terbium. The same chemist has discovered another metal, which he calls "decipium," in North Carolinian Amarskite.

"KERITE," a kind of artificial caoutchouc, is the invention of Mr. Day of New York, and is made as follows:—To produce 100 parts by weight of Kerite, 27 parts of cotton oil, and 30 parts of oil-tar are heated together in a cauldron for several hours, at a temperature of about 150° C. After this has been done, 30 parts of linseed oil, 12 parts of sulphur, and 5 of ordinary wax or of solid paraffine are added. The whole is then heated for five or six hours, at a temperature under 150° C. to prevent carbonisation. It is then allowed to cool, and is moulded into blocks convenient for future purposes. The price is about one-third of the natural caoutchouc. Mr. Day received honourable mention for Kerite insulated telegraph core, exhibited at the Paris Exhibition.

IT is proposed to make Paris a seaport town by deepening the Seine from the sea upwards; and it is calculated that, if no extraordinary difficulties are encountered, the bed of that river could be sufficiently deepened in four or five years to allow vessels of 800 tons to get as far as the capital. This alteration, says *Engineering*, would allow the French to compete with foreign coal.

AN ALLOTROPIC MODIFICATION OF COPPER.—M. Schutzenberger communicates the following facts in evidence of an allotropic form of copper yielded by electrolysis of certain copper solution. He took an electrolysing bath, made of a solution of one hundred parts of acetate of copper in ten of water, and boiled for some minutes to expel acetic acid and render it slightly basic. The battery employed was two Bunsen or three Daniell elements, of medium size, so as to avoid all elevation of temperature in the bath. The negative electrode platinum is placed parallel to the positive electrode copper in the bath, at a distance of from three to four centimetres. The dimensions of the platinum electrode should be a little less than those of the copper. In these circumstances the face of the platinum electrode is covered with a layer of allotropic copper, whilst the copper electrode opposite receives a much thinner deposit of ordinary copper. If the negative electrode is notably thicker than the positive, the modified copper deposit is placed opposite the latter, and is encased with ordinary copper. In this way can be obtained simultaneously, and side by side, two kinds of copper, which by their characteristics are quite distinct. The allotropic copper takes the form of plates with a metallic lustre, a roughened surface on the free side, and a polished surface on the side next the platinum plate. If the operation is sufficiently prolonged, it forms at the inferior angles and at the borders of the negative electrode some beautiful arborescences, directed towards the positive plate, whose branches, ramifying like those of a tree, sometimes attain a length of several centimetres before they break off by their own weight. The allotropic copper is less red than the ordinary, and approaches the colour of certain bronzes. The plates are easily detached from the negative electrode after being washed with boiling water and dried in a vacuum at the ordinary temperature. They are broken up, entirely deprived of malleability, and reduced to an impalpable powder, like sulphur, by braying them in an agate mortar. The density of this form of copper has not yet been exactly measured, it being always mixed with from five to ten per cent. of oxide, of which the origin is explained by the extreme oxidisability of the allotropic copper. The specific gravity is, however, very nearly 8 or 8·2, while that of ordinary copper is 6·9.

The plates washed with boiling water and exposed moist to the air, oxidise on the surface very rapidly, acquiring beautiful tints, and after a few minutes taking a deep indigo blue colour. In ærated water at 50° or 60° C., and in a cold solution of basic acetate of copper, the oxidation is instantaneous; and the electrolysis of a bath of basic acetate only furnishes at the beginning some deposits very rich in oxide; it is only at the end of a certain time when the bath has become almost neutral, that the operation goes on regularly.

Allotropic copper exposed to the contact of the air as a dry powder and at ordinary temperature, becomes black at the end of a short time, and changes into copper oxide, soluble in cold dilute sulphuric acid.

The way in which it behaves in pure nitric acid, diluted with six times its weight in cold water, is characteristic. Its surface, if it be oxidised, soon brightens, and then the metal is immediately attacked with disengagement of nitric protoxide almost pure, covering itself at the same time with a coating of olive black, of which the composition is as yet undetermined. Ordinary copper is hardly attacked at all by azotic acid, diluted 10 per cent., and with more concentrated acid, the nitric bioxide is chiefly given off, but without the blackening of the metal. Plates are sometimes obtained which give, on dissolution, a dilute nitric acid, mixtures of protoxide and bioxide ($\frac{3}{4}$ to $\frac{3}{4}$ N^2O for $\frac{1}{4}$ to $\frac{1}{4}$ NO); it is easy to make sure that they are formed of a mixture of the two coppers. This effect takes place when the bath is warmed during electrolysis, or if it is acid. Allotropic copper is converted into ordinary copper by the action of heat in prolonged contact with a dilute solution of sulphuric acid. On one occasion, M. Schutzenberger found a considerable mass of allotropic copper in a powdery state and dried in a vacuum, to become suddenly transformed into ordinary copper, with a notable disengagement of heat at the instant of its return into the air. Incipient oxidation might be a determining cause of the phenomenon, but it cannot explain the notable discharge of heat, for the metallic aspect of the powder had not changed, and analysis did not reveal much more oxygen after than before (about 1 per cent).

Heated to 100° C. in the vacuum or carbonic acid the allotropic copper does not give off hydrogen. The difference of physical properties ought not therefore to be attributed to the presence of a hydrate of copper or occluded hydrogen, and is only to be explained by the existence of a special modification of the copper, susceptible of being oxidised cold, and yielding bioxide of copper, and of dissolving and blackening in very dilute nitric acid. It is probable that this modification corresponds to the copper of cupric salts. In changing into ordinary copper it gives out heat, and furnishes by oxidation cuprous oxide before passing to the state of cupric oxide.

INDIA-RUBBER.—On the upper as well as the lower waters of the Amazon, there is a growing dearth of rubber, owing to the pernicious system of trading introduced by the Para rubber merchants, and also to the ill-treatment of the ceringa trees by the collectors. The

credit system, fostered by the merchants, makes the Indians improvident, and dishonest Indians neglect their engagements. The rubber supply is consequently deficient and inferior, and the trees too severely drained of juice. The Brazilian Government are, however, about to correct this abuse.

CHEAP LIGHT.—A Master of Arts, Cambridge, informs us that he witnessed recently at Brighton a dial rendered luminous by a phosphorescent substance, which absorbed the sunlight and emitted it again after the departure of the orb of day. "May we not," he asks, "expect to see, on this principle, a luminous dial over every door in London?" There is here no question as in the case of electricity *v.* gas, of the comparative cost, the solar rays shining, as Perdita says, on all alike. I am reminded of a saying of the Roman philosopher, Pliny the younger—"*Mihi multum cogitante persuasit Natura nihil incredibile esse existimem de illa.*" These luminous dials are probably an application of Balmain's patent, No. 4152, 1877, for luminous paints. Luminous house numbers would be a small but serviceable application of the process, which we would suggest to Mr. Balmain. Another is luminous backs for public seats in parks, &c., thus obviating Dr. Lacomme's electrical apparatus for the same end. This mode of illumination is in a state of very feeble infancy; but what with the advance of chemistry and physics, we do not know how important it may become. We may be yet enabled to store the elusive radiant energy of solar and electric light or heat just as we can now store up chemical, mechanical, and electrical energy.

LIGHTNING ROD CONFERENCE.

IN response to an invitation issued by the Meteorological Society, a Lightning Rod Conference will be held shortly under the presidency of Mr. C. Brooke, F.R.S. The following gentlemen have been nominated as delegates by the several societies, viz.:—

ROYAL INSTITUTE OF BRITISH ARCHITECTS.—J. Whichcord, Esq., F.S.A., Vice-President; Prof. Lewis, F.S.A.

SOCIETY OF TELEGRAPH ENGINEERS.—J. Latimer Clark, Esq., M.I.C.E., Past President; W. H. Preece, Esq., M.I.C.E., Vice-President.

PHYSICAL SOCIETY.—Prof. W. G. Adams, F.R.S., President; Prof. G. Carey Foster, F.R.S., Past President.

METEOROLOGICAL SOCIETY.—C. Brooke, Esq., F.R.S., Past President; E. E. Dymond, Esq.; G. J. Symons, Esq., F.R.S., Secretary.

The Secretary to the Conference will be Mr. G. J. Symons.

On November 15th, the Western and Brazilian Telegraph Company notified that telegraphic communication by cable had been restored between Bahia and Rio de Janeiro.

The Great Northern Telegraph Company also gave notification on the 14th inst, of the repair of their cable between Nagasaki and Shanghai, messages being again received for all stations in China as well as Japan.

The following are the late quotations of telegraphs:—Anglo-American, Limited, $59\frac{1}{2}$-60; Ditto, Preferred, $85\frac{1}{2}$-$86\frac{1}{2}$; Ditto, Deferred, $34\frac{1}{2}$-$35\frac{1}{2}$; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, $6\frac{3}{8}$-$6\frac{5}{8}$; Cuba, Limited, 8-$8\frac{1}{2}$; Cuba, Limited, 10 per cent. Preference, $15\frac{1}{4}$-$15\frac{3}{4}$; Direct Spanish, Limited, 2-$2\frac{1}{2}$; Direct Spanish, 10 per cent. Preference, $9\frac{3}{4}$-$10\frac{1}{4}$; Direct United States Cable, Limited, 1877, $12\frac{3}{8}$-$12\frac{7}{8}$; Eastern, Limited, $7\frac{3}{8}$-$7\frac{5}{8}$; Eastern, 6 per cent. Debentures repayable October, 1883, 103-106; Eastern 5 per cent. Debentures repayable August, 1887, 99-101; Eastern, 6 per cent. Preference, $10\frac{7}{8}$-$11\frac{1}{8}$; Eastern Extension, Australasian and China Limited, 7-$7\frac{1}{4}$; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 104-107; German Union Telegraph and Trust, 8-$8\frac{1}{2}$; Globe Telegraph and Trust, Limited, $4\frac{7}{8}$-$5\frac{1}{8}$; Globe, 6 per cent. Preference, $10\frac{1}{4}$-$10\frac{1}{2}$; Great Northern, $7\frac{7}{8}$-$8\frac{1}{8}$; Indo-European, Limited, 20-21; Mediterranean Extension, Limited, $2\frac{3}{4}$-3; Mediterranean Extension, 8 per cent. Preference, $8\frac{3}{4}$-$9\frac{1}{4}$; Reuter's, Limited, $9\frac{1}{4}$-$10\frac{1}{4}$; Submarine, 215-220; Submarine Scrip, $1\frac{3}{4}$-2; West India and Panama, Limited, $1\frac{3}{4}$-2; Ditto, 6 per cent. First Preference, $7\frac{3}{4}$-$8\frac{1}{4}$; Ditto, ditto, Second Preference, $7\frac{1}{2}$-8; Western and Brazilian, Limited, $2\frac{1}{2}$-3; Ditto, 6 per cent. Debentures "A," 90-94, Ditto, ditto, ditto, "B," 84-88; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds; 114-118; Ditto, 6 per cent. Sterling Bonds, 100-102; Telegraph Construction and Maintenance, Limited, $29\frac{1}{4}$-$30\frac{1}{4}$; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, $2\frac{1}{2}$-3; India Rubber Co., 29-30.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,102,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
October, 1878 ...	54,150	13,138	* 2,800	1,107	* 18,050	41,678	23,393	19,737	... ...	10,689	2,750	*b*	* 5,143
October, 1877 ...	49,510	11,387	2,933	914	13,486	37,402	21,388	21,210	... ...	10,823	2,225	10,037	4,563
Increase	4,640	1,751	... ...	193	4,564	4,276	2,005	... ...	... ...	... ...	525	... ...	580
Decrease	... ...	... ...	133	... ...	... ...	... ...	... ...	1,473	... ...	134	... ...	... ...	... ...

* Estimated. *b* Not published.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness.)

THE TELEGRAPHIC JOURNAL.
Vol. VI.—No. 141.

THE SOURCE OF TELEPHONIC SOUNDS.

In this issue we give the conclusion of Professor Hughes' interesting investigation into the source of sound in the speaking telephone. These experiments are of course applicable only to those telephones, typified by the Bell, in which a magnetic field and diaphragm are employed; and they show very clearly that we cannot hope to improve an electro-magnetic telephone by abandoning either the one or the other.

Without the telephone, the microphone would not have seen the light; but in the work in question Professor Hughes has paid his debt to the telephone by investigating the true source of its sounds, with the help of the microphone. Many of the results educed in his research had been got before; but no one has so thoroughly and consistently traced the telephone sounds to their seat as Professor Hughes has done. The condition of the problem before these experiments were made was well stated by Professor Fleeming Jenkin (see Telegraphic Journal, Vol. VI., p. 441, Nov. 1), who referred the chief source of sound to molecular action in the core (Page effect), supported by the vibrations of the disc. "Thus," he says, "when the ferrotype receiving disc is present we hear at least two simultaneous voices—the voice of the disc, which is strong, and the voice of the magnet, which is weak. When for the ferrotype disc we substitute a wooden plate, this plate will act as a sounding board for the Page effect." When the diaphragm is a conductor a third source of sound (Ampère effect) is caused by the induction of the changing magnetic field; and a fourth source might exist in the self-induction of the coil on itself (De la Rue effect).

It remains to be seen what interpretation different *savants* will place upon Professor Hughes' results; but it appears to us that the Professor's own conclusions are just, and that the main source of sound in the telephone is the sensitiveness of the diaphragm, *as a magnet transversely polarised*, to changes in the magnetic field around it. On this supposition, were the earth's magnetism powerful enough, no permanent magnet would be required for the telephone. It appears to us that an attentive study of Prof. Hughes' paper will lead to improvements, not only in the telephone itself, but in other electro-magnetic and induction relations. It will be seen from it that the inventor of the telephone, groping blindly as he did, has arrived at a form which is very nearly the best theoretically. The improvements on it that may be effected relate to the thinness and elasticity of the plate, and the form of the coil and its position with respect to the magnet and disc.

Experiment XXXII has a particular bearing on the changes which go on in a magnetic field, the action of the current in the coil when the current passes being apparently to quench the magnetism of the field around the pole of the magnet. This is a case which might be elucidated by Prof. Sylvanus Thomson's magnetic figures, and we take the liberty of recommending it to his study.

In conclusion, we may add that we shall shortly publish an investigation by Prof. Hughes in a different direction, and which, we think, will open up an entirely new field of research and electrical advance.

THE SOURCE OF SOUND IN THE TELEPHONE.

An Experimental Investigation by Aid of the Microphone.

By Prof. D. E. Hughes.

(*Concluded from page* 471.)

XXXII.—Pendulum Experiments, *Continued.*—If the pendulum bob be a small and strongly magnetised steel bar or needle, and the flat coil be placed parallel to it, as in a galvanometer, but at a distance of 1 inch, the needle turns upon its axis on the passage of the current through the coil, like the needle in an ordinary galvanometer; but if we place a bar magnet at a distance from the coil and needle of 2 inches, and perpendicular to the axis of the coil, we find that upon the passage of the current the needle has only a feeble tendency to turn on its axis, whereas it has a strong tendency to *swing* in the line of the magnet along the coil; the needle being now repelled from the magnet by the current which attracted it when the same pole of the magnet was put in the coil. In these conditions we obtain a full swing of 3 inches right across the poles of the coil under whose influence it is set in motion. We wish to point out in this experiment the remarkable power of the coil on the magnetic field in comparison with its effects upon the magnet itself. If the coil had changed the polarity or distribution of magnetism upon the magnet, it should have done so transversely and not longitudinally; the needle then instead of swinging in a line with the magnet should have turned on its axis as it did before it was brought under the influence of the magnet.

(A confirmation of this experiment also takes place in the telephone; for if, instead of having the coil on the magnet as usual, we place the coil exterior to it and its axis perpendicular to the magnet, the sounds obtained are almost if not quite as loud and distinct as when the magnet is inside the coil.)

XXXIII.—If we compare on the pendulum, iron or steel feebly magnetised, and steel strongly magnetised, when acted upon by the flat coil alone, we find that iron gives but ¼ inch swing, steel feebly magnetised ¾ inch swing, and the same steel strongly magnetised 2 inches swing. Comparing again the action of the long ordinary helix and flat coil, mentioned in Experiment III, we find that the long helix gives but ¾ inch swing against 2 to 3 inch swing for the flat coil, thus demonstrating the entire concordance of the pendulum experiments with those previously made by means of the microphone; the one giving the results in visible motion, the other in sound.

The pendulum experiments were repeated by changing the mode of suspension, using a square frame 10 by 10 inches, over which was stretched a fine linen cloth, the piece of steel or other material under investigation being attached to its centre. Thus we had a true diaphragm whose movements were visible, but as it is evident that the mode of suspension could not change the laws by which such bodies are put in motion, we do not deem it necessary to detail the results which, of course, were identical.

Again to verify the acoustical results obtained by the microphone; a small wooden resonant box was used, which could be placed to the ear and serve as a mechanical microphone. We could thus hear most of the experiments, the sound being sufficiently strong; but although we could thus obtain indications, they were far less reliable than those given by the microphone, the box giving out only those sounds which were almost sufficiently audible without, and the tones being not the true timbre of the piece under investigation, but those simply of the box itself. The microphone on the other hand revealed sounds which were quite inaudible without its aid, and rendered the true timbre peculiar to each object.

The whole of the preceding microphonic experiments were repeated with induced currents in place of the voltaic currents. The transmitting microphone then acting in the primary circuit, the currents from the secondary being directed upon the organ under investigation, no difference whatever was found in the comparative results. The current was also reduced gradually by resistance until feebler than ordinary telephone currents, giving still the same comparative results. As the currents decreased in strength the effects dwindled until they finally disappeared. The object of this experiment was simply to meet any objection to the effect that the experiments having been carried on by voltaic currents, the results, with induced or feeble telephonic currents, would be different.

We have seen that with strong currents the movements of the diaphragm became visible, and gradually faded as the current became weaker. There can be no reason to suppose any change of law as regards the reaction on the diaphragm, during its gradual decline of movement. For if we strike a wine glass or bell with sufficient force we may easily render the vibrations visible, but if we touch it lightly, we still hear distinctly its sound, although its vibrations are no longer visible. It is simply a proof of the wonderful sensitiveness of the human ear to feeble but rapid vibrations; and to the ear alone is due the perception of feeble mechanical movements by feeble currents in the telephone.

We can clearly trace the telephone backwards to the one great discovery of Oersted of which the galvanometer was simply an extension; and as the telephone is based upon similar principles to the galvanometer, it is not so remarkable that both should be the most sensitive organs we possess for investigations by means of voltaic currents. The one is a visual, the other an auricular arrangement of the same forces, and the telephone may be regarded simply as an acoustical galvanometer, or rather, galvanoscope.

After careful verification of the preceding experiments (which, it must be understood relate exclusively to those receiving telephones which employ a diaphragm and magnetic field), I have come to the conclusion that it is not at all necessary to call on any molecular theory to explain the action of the telephone, and that all its effects have, from a theoretical point of view, long been known. From the preceding experiments I draw the inference that the extreme sensitiveness of the telephone to feeble but rapid changes of current is due to a large surface of iron under excellent conditions as regards elasticity and freedom of motion in a high magnetic field, such as the diaphragm is known to be, and that the comparatively large motion that we obtain in this diaphragm from feeble currents is not so much due to electro-magnetic changes taking place in the diaphragm or magnet itself (see Ex. XXXI.) as to the sensitiveness, all fixed magnetic bodies possess to any change in their field of force. And if we are able thus to perceive sounds from actions so comparatively feeble it is due to the fact that the human ear is capable of appreciating sonorous waves caused by a motion too small for the perception of any other of our senses.

THE WANDERING ELECTRIC SPARK.

By GASTON PLANTÉ.

THE condensers, with mica plates, which are employed in the construction of my *rheostatic* machine (1), are sometimes pierced when the plates of mica are very thin, under the action of a current from 800 secondary batteries, in the same way as the glass of a Leyden jar would be pierced when charged too highly by an electrical machine.

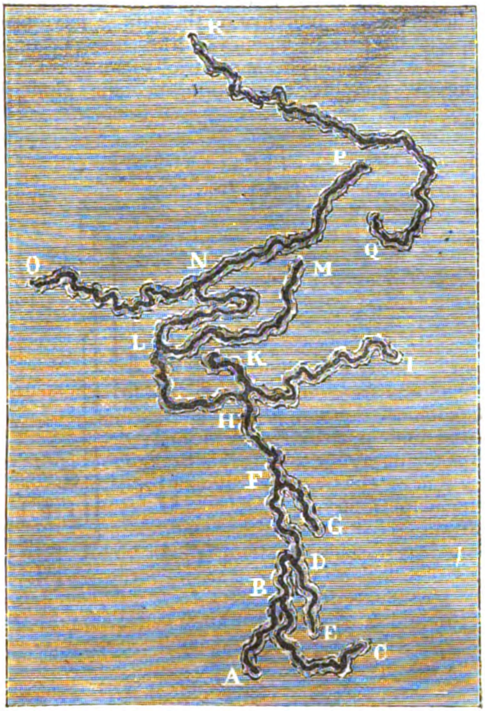
These accidents have given me an opportunity of observing a very curious fact, viz., the slow and progressive march of the electric spark, and of noteing the successive development of its capricious sinuosities.

One of the condensers being placed upon an insulated metal plate, connected to one pole of the secondary battery, if the upper condenser plate is touched with the other pole of the secondary battery, a spark bursts on a point of the surface of the condenser where the mica is too thin, or cracked. This spark moves about in the form of a small and

(1) *Telegraphic Journal*, Vol. 5, p. 309. Comptes-Rendus, Vol. 85, p. 794, and Vol. 86, p. 761.

very brilliant luminous globule, which is accompanied by a peculiar roaring, and furrows upon the tin plate of the condenser a deep groove, sinuous and irregular.

The figure here given is an exact copy of the portion of the surface of a condenser on which the phenomenon has been produced.



The spark appeared first at A, then spread immediately to B and C; it then disappeared, to immediately reappear at B, with such rapidity and in an interval of time so scarcely appreciable that it seemed to have made a bound; it then moved towards D, there forming a new ramification, which stopped at F, reappeared at D, continued its progress towards F, and so on. Sometimes, as in the present case, the spark appeared afresh further on, at a point R, detached from the principal groove, stopping afterwards at R, and the phenomenon only ceased when the mica plate did not present any part sufficiently thin to be pierced. In other cases the spark remained for some time stationary around the same point, at other times one of the ramifications became greatly enlarged, and described over the whole surface contours like those on a map.

A tube of distilled water was interposed in the circuit of the secondary battery, in order to avoid the too great heating effects, and the consequent burning of the whole of the condenser.

Whilst the phenomenon is being produced, one cannot foresee by what points the spark will pass, and nothing is more odd than the progress of this little dazzling globule which walks slowly about and choses the points to which it directs itself, following the greater or less resistance of different points of the insulated plate.

The condenser becomes cut open by the passage of the spark, and the tin forms a double chaplet of melted beads around the edges of the consumed mica. It is a kind of voltaic arc, which is produced successively at the expense of the substance of the condenser, as in the electric candles of M. Jablochkoff; but the mica here adds to the brilliancy of the globule more than the incandescence of the metal, in producing, like quartz and silicates, the *electrosilicic* light (1).

This experiment may throw a new light upon the phenomenon of fire balls. It comprises the views already put forward upon this subject by M. du Moncel (2) in 1857, and the considerations which I have already published in connection with other experiments (3). For in the phenomena of globular lightning the elements of a condenser exist, a column of moist air strongly electrified playing the *rôle* of the upper condenser-plate, the earth that of the lower plate, and the layer of air between that of the insulated plate.

Here the spark is, undoubtedly, a globule of matter in fusion, of a nature different from that which constitutes fulminatory balls. But I have observed also (4) that it is possible to obtain with *dynamic electricity* of high tension globular electric flames formed entirely of the elements of the air and of the gases of rarefied and incandescent steam, and that these globules follow naturally the course traced by the electrode over the conducting surface.

It only remained for me to show that the luminous electric globules formed of other matter, can move spontaneously and slowly, whilst the electrode is immoveable.

The experiment which I have just described supplies this evidence, and appears to me to specially explain the *slow* and capricious movement of the fire-ball.

A NEW FORM OF LIGHTNING DISCHARGER.

By J. RYMER-JONES, late Electrician to the Imperia Government Telegraphs, Japan.

THE principle involved in this instrument is somewhat analogous to that of the *attracted disc*, or *trap-door* electrometer of Sir William Thomson, inasmuch as it depends on the mutual attraction of

(1) Comptes-Rendus, Vol. 84, p. 914.

(2) Note on Thunder and Lightning, by the Count du Moncel 1857, p. 49.

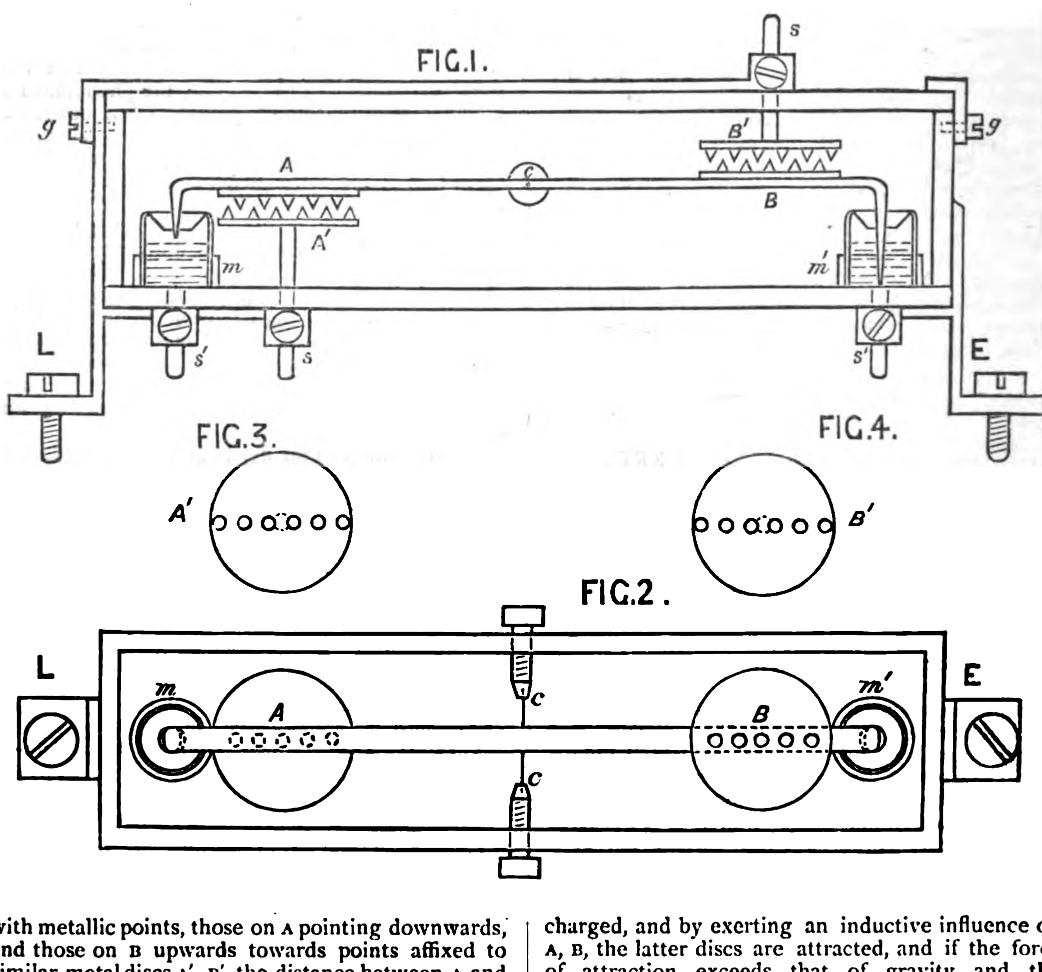
(3) Bulletin de l'Association Scientifique de France, No. 457, p. 305.

(4) *Telegraphic Journal*, Vol. 6, page 139, Comptes-Rendus, Vol. 85, p. 619 and 622.

metallic discs oppositely electrified, the strength of that attraction determining the relative proximity of the discs.

Fig. 1 is a section, and fig. 2 a plan of the instrument (the cover and with it the plate B′ has been removed in order to show the balance portion), while figs. 3 and 4 show the distribution of points on the discs A′ and B′. A and B (figs. 1 and 2), are two copper discs, attached to the under and upper surfaces respectively of a stout copper rod, which being pivoted at *c*, *c*, forms a very delicate balance. The ends of the axis *c*, *c*, move freely in holes drilled in the ends of the screws, as shown in fig. 2. The discs at either end of the balance are provided while the whole of the balance, including the rod and discs A, B, are in permanent connection with the earth through the mercury in the cup *m*′, which is in metallic connection with terminal E.

The *modus operandi* is as follows :—So long as the line is free from the influence of atmospheric electricity, by virtue of B being slightly the heavier of the two arms, gravity operates, and draws it down till the prolongation at that end rests on the bottom of the mercury cup *m*′. If now the plates A′, B′, and the level of the mercury in the cup *m* have been properly adjusted, whenever the line becomes charged with atmospheric electricity, the discs A′, B′, being in metallic connection, become similarly



with metallic points, those on A pointing downwards, and those on B upwards towards points affixed to similar metal discs A′, B′, the distance between A and A′, and B and B′ being capable of adjustment by suitable screws *s*, *s*. From the extremities of the balance depend two arms—that on the right hand dipping into mercury in the cup *m*′, while the left hand prolongation, so long as the balance is in its normal position, hangs over, but does not touch the surface of mercury in the cup *m*. The cups are provided with adjusting screws *s*′, *s*′, similar to those of the plates A′, B′. These two last mentioned discs, and also the mercury in the cup *m*, are all in electrical communication with the line terminal L; charged, and by exerting an inductive influence on A, B, the latter discs are attracted, and if the force of attraction exceeds that of gravity and the inertia of the instrument, their points are brought nearer together, and thus the rate of discharge is increased. Should the attraction be excessive, the points distributed along the discs, by coming in actual contact with the opposing surfaces of the plates, put the line direct to earth. This is also more effectually done perhaps by the prolongation at A, which dips into the mercury at *m*, and by so doing puts the line to earth, and assists the points to discharge the line. When the discharge ceases the attraction of gravity reasserts itself, and,

by drawing B down, breaks the earth connection. The cups which contain the mercury are formed by small portions of test tubes, the rounded bottom being slightly softened by heat, and pressed inwards by a suitable point, so as to form a hole of the proper dimensions. This forms the top of the cup, which resembles somewhat the top of a *safety ink-bottle.* The bottom of the tube is open and is cemented into a brass cup, as shown in fig. 1. Not only does this form of cup circumscribe any possible splutterings of the mercury, but the level of the mercury is also seen through the glass, and, since the sides of the instrument case are of glass, adjustments may be made without removing the cover. When, however, this is necessary, in order to fill the cups and fix the balance, it is readily done by removing the screws *g g*, when the cover, together with the plate B′, may be taken off.

Although such a modification will materially reduce the efficiency of the discharger, it is evident that by varying the connections, and putting A′ to line and B′ to earth, or *vice versâ*, the balance, when attracted, forms a bridge between the two. By employing the mercury cups, however, the contact with earth is not only more perfect, but there is less danger of the plates being fused together, as is not unfrequently the case with the ordinary *plate-dischargers.* Moreover, as the instrument is dust-tight and firmly screwed down, the mercury contacts, when once adjusted, need furnish no source of inconvenience.

GRAMME'S ALTERNATING CURRENT MACHINE.

By ALF. NIAUDET.

It will be remembered that M. Jablochkoff endeavoured during several months to kindle his electric candles by means of currents from a battery, or from the ordinary Gramme machine. He succeeded in placing six candles in one continuous circuit, but could not get them to keep alight for more than twenty minutes at a time, owing to the unequal wasting of the carbons, and he therefore had recourse to alternating currents, which traversed the carbons alternately in opposite directions and wasted them equally, a plan which was a practical success.

This new demand obliged M. Gramme to produce an alternating current machine; and here it may be remarked that the invention of a continuous current machine is very difficult, and there are only two or three of them which are truly original; but the production of an alternating current machine is relatively easy.

M. Gramme, before arriving at the crowning invention which made his reputation, had patented a score of machines giving reverse currents, some of which are very interesting. He was therefore prepared to furnish M. Jablochkoff the machine which he required.

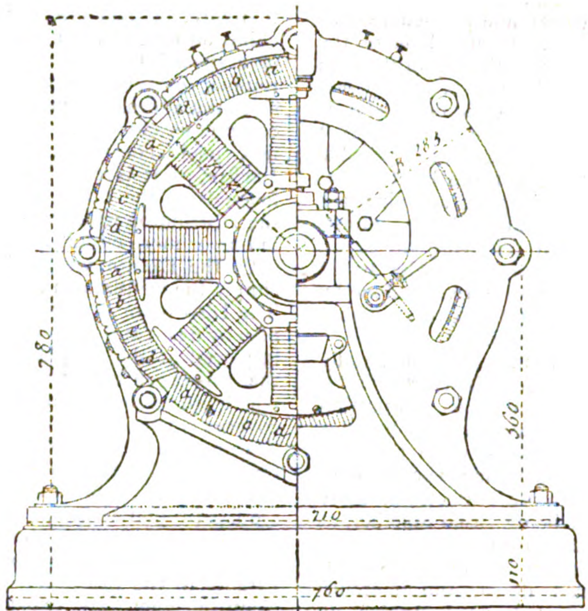
Before entering on the description of this machine, we should remind our readers that the power of an electro-magnet is easily rendered much greater than that of a permanent magnet. Given equal volumes, a machine with electro-magnets is much more energetic than one with steel magnets. M. Gramme, therefore, adopted electro-magnets for the new machine, although their use involved the employment of a special Gramme machine to supply the continuous currents necessary to magnetise them, since the alternating machine itself did not generate continuous currents. The alternating apparatus as now made consists, then, of two machines, the Excitor, as it is called, which excites the electro-magnets of the other, and is relatively small, and the Distributor, which furnishes alternating currents in one or more circuits.

Of the Excitor we need say nothing here; it is simply the well-known continuous current Gramme. The Distributor is represented in end elevation and plan by figs. 1 and 2. A large "Gramme ring," fig. 1, is placed at the periphery. It will be remembered that this organ is composed of a soft iron ring, on which are wound, parallel to its axis, coils of cotton-covered copper wire. Whilst the ring of the ordinary Gramme machine is acted upon by induction from the outside, the ring in question is subjected to induction from within by eight electro-magnets which are fixed round an axle. The cores of these electro-magnets are placed, as shown, so as to radiate from the axle; and the wire is wound upon these cores parallel to the axle. The exterior poles of these electro-magnets are expanded so as to act on a larger extent of the outer ring. They are all excited by a continuous current from the Excitor in such a manner that the alternate poles are of opposite name, thus N, S, N, S, and so on. Now, when the system of electro-magnets is rotated round the axis in the centre of the fixed outer ring, each of the wires crossing the inside of the said ring, finds itself placed alternately between a north pole and the iron of the ring, and then between a south pole and the iron of the ring, that is, under contrary inductive influences. All these wires wound round the ring being fixed, they can be associated in different ways; but in actual practice they are arranged so as to make 32 sections, marked *a, b, c, d; a, b, c, d*, &c., as shown in the figure. These sections are associated in four groups, each of 8 sections or elements; the first being composed of all the sections marked *a*; the second of all those marked *b*, and so on. It will be readily seen from the figure that the 8 elements *a* are placed in the same position relatively to the eight poles of the multiple electro-magnet, which turns in the middle; and from this it will be seen that these 8 elements are grouped together because at each instant they are traversed by currents of equal intensity. It will be seen, too, that it would be easy to divide the eighth parts of the ring (*a, b, c, d*) into more than four sections; for example into eight sections, thus giving eight instead of four distinct currents. The dimensions given are in millimetres.

The intensity of these alternating currents of course varies with the intensity of the electro-magnets, and the speed of rotation of the central armature. For large machines, feeding 16 or 20 candles, the speed amounts to 600 turns per minute, and consequently there are 600 by 8, or 4,800 reversals of currents per minute.

In small machines, feeding four candles, the speed

FIG. 1.



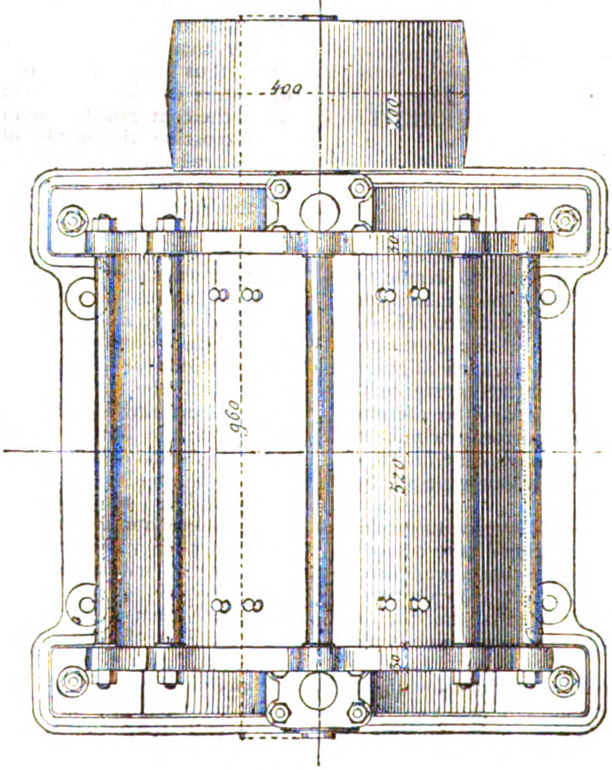
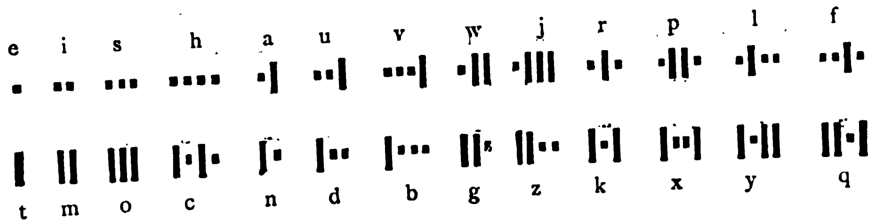


FIG. 2.

is carried to 700 turns a minute, and the number of reversals is, therefore, 5,600 a minute. The large machines, divided into four circuits, furnish the currents for four circuits of four or five candles each, making, in all, 16 or 20 candles, according to the requirements of the locality. Each of these candles yields a light equal to 100 Carcel jets or about 800 standard sperm candles. The motive power necessary for producing these 20 lights is about 20 horse-power.

HERRING'S PRINTING TELEGRAPH.

This instrument, which has caused so much discussion of late, is constructed to print the dot and dash of the Morse alphabet in such a manner that one can never be mistaken for the other. The following is a key to the Postal Telegraph Alphabet, as printed by Mr. Herring's system—



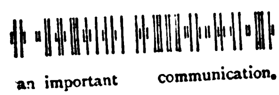
This is effected by the use of two distinct levers—an arrangement which permits the dot and dash to be printed vertical instead of longitudinal, and to be produced instantaneously instead of by continued pressure, thus saving the time of the operator and very considerably diminishing the length of the message slip. The coil of paper on which the message is received is made to travel by clockwork in the ordinary way. It passes directly over a thin metallic disc placed transversely to the course of the slip, revolving on an axis and dipping into an ink well. Over the paper is the lever terminating in a broad style placed vertically above the disc so that the descent of the lever compresses the slip of paper between the disc and the style. The central portion of the lever carrying the central portion of the style can be acted upon either independently of the lateral portions or together with them. In the one case only the narrow central portion of the style descends, and the slip of paper is pressed upon the inking disc at only a single point of contact, which produces a vertical dot, and in the other case the style descends as a whole, and having a concave edge it presses the paper into contact with the disc, thus producing a vertical dash. The pressure of the style stops for the moment the revolution of the inking disc upon the immediate recommencement of which the ink supply depends.

Mr. Herring has therefore placed upon the axle of the disc a box containing a spiral spring, so arranged that when the disc itself is checked, the power of the clockwork coils the spring. The moment the disc is released the coiled spring gives the necessary impulse to produce immediate revolution. Each lever also serves to clamp the paper at every impression, thus insuring perfect clearness and regularity in the signs.

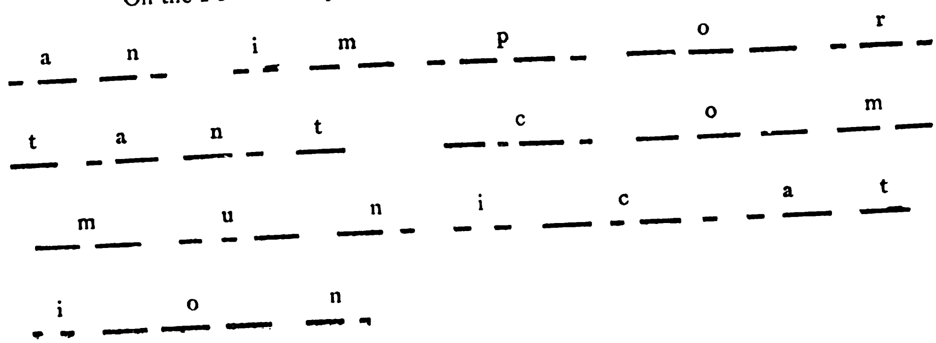
The operator is furnished with two keys, one of which commands the central or dot portion of the lever and the lever as a whole. One therefore produces the dot and the other the dash, and no mistake can occur between the two except by the use of the wrong key. The printing is remarkably clear, distinct, and compact, and gives a legibility to the messages which no other modification of the Morse system has ever attained.

The utility of Mr. Herring's system in transmitting and recording messages may be partly perceived from the following comparison between it and the system of the Post Office.

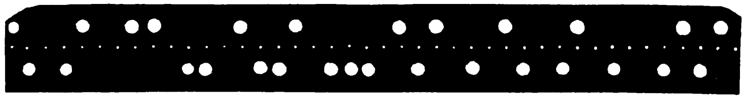
On Mr. Herring's system a message would be recorded thus:—



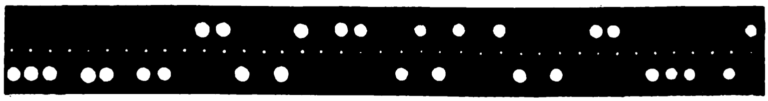
On the Post Office system the same words would be recorded thus:—



On Mr. Herring's system the same message would be automatically transmitted thus :—



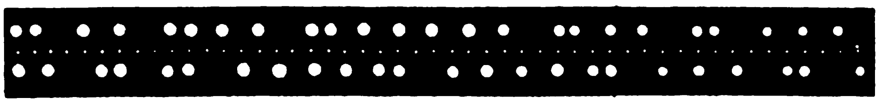
a n i m p o r t a n t c



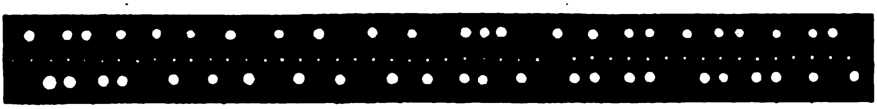
o m m u n i c a t i o n

(*Requiring only* 56 *Perforations.*)

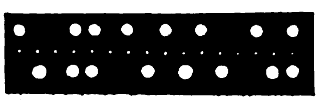
On the Post Office system the same message would be automatically transmitted thus :—



a n i m p o r t a n t



c o m m u n i c a



t i o n

(*Requiring* 112 *Perforations.*)

Mr. Latimer Clark has made a report upon Mr. Herring's system, from which we extract the following :—

1st.—We are of opinion that your Instrument will work on all ordinary circuits at a greater speed both for hand and mechanical sending than the ordinary Morse now in use, in consequence of the dashes being made in the same space of time as the dots.

2nd.—In comparison with the Morse the signals given by your Instrument are necessarily more legible, and may be more accurately deciphered, in consequence of the dashes being upright, and of uniform size and character. Owing to the vertical position of your dashes, it is impossible for a clerk to be in doubt as to which are dots and which are dashes, as is so liable to occur with the ordinary Morse writing.

3rd.—Owing to the contacts for dots and dashes being alike, ordinary telegraph clerks can learn to work your instrument with greater facility than they could the Morse.

4th.—There is no doubt that the saving in the cost of paper for your system is very considerable, and would form an important item of economy in a year's work. This saving would probably be equal to sixty-five or seventy-five per cent. The compactness of the messages by your system is very remarkable.

5th.—With reference to mechanical sending, the punched paper used for your system is more simple than that required for the ordinary Morse, and it is also stronger, owing to the fewer perforations—exactly half the number required for the Morse signals.

6th.—Your Instrument is peculiarly adapted for reading by sound.

There is of course some inconvenience in having several kinds of instruments in common use, and the addition of one more to the present number is to that extent objectionable.

The insulation of the lines in this country is, however, now so excellent, and the advantages which your system affords are attended by so few inconveniences, that we think your instrument might at once be employed on many lines with decided advantage.

D'ARLINCOURT'S AUTOGRAPHIC TELEGRAPH APPARATUS.

A TELEGRAPH instrument which would transmit an autographic copy of a message has been more than once invented and practically tried, and with a considerable amount of success. As early as 1850, Mr. C. F. Bakewell invented an instrument of this description, by which despatches were transmitted

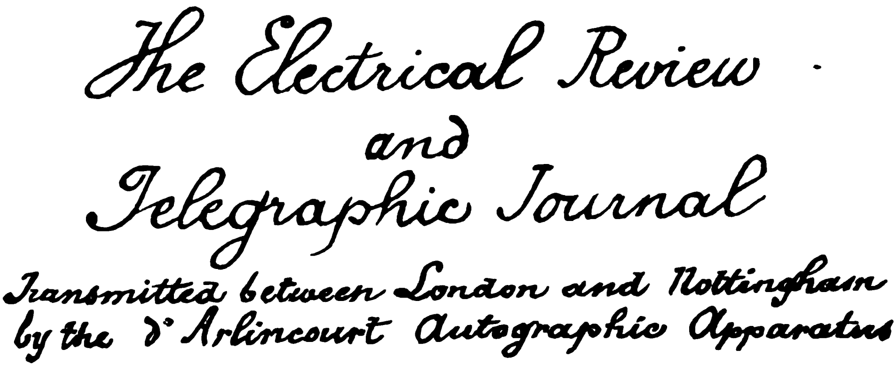


FIG. 1.

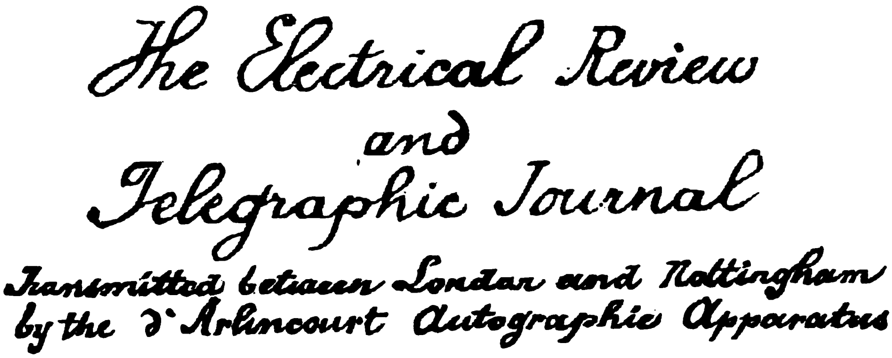


FIG. 2.

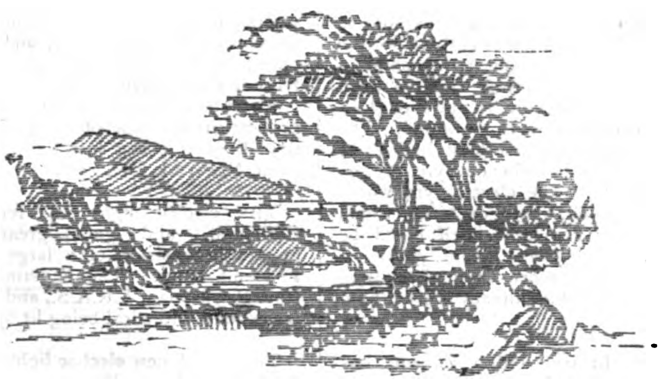


FIG. 3.

in the actual handwriting of the sender. Subsequently M. C. Cros, of Paris, the Abbe Caselli, M. Lenori, M. Meyer, and others invented apparatus for effecting the same object. The invention of the latter gentleman differed from those of Bakewell, Cros, Caselli, and Lenori, in that it produced the facsimile of the writer's copy, in printing ink, whilst the other forms of apparatus obtained the copies by the decomposition of a solution with which the paper on which the facsimile was produced, was moistened, as in the instrument of Bain.

Within the last few years M. D'Arlincourt has turned his attention to the subject, and has succeeded in producing an instrument which effects the autographic principle in a very efficient and satisfactory manner. We intend in an early number to give a description of M. D'Arlincourt's apparatus, which may prove interesting to our readers since the system has within the last few days been worked with success on some of the lines of the Postal Telegraphs. We are able in the present number, through the kindness of M. Gottschalk, M. D'Arlincourt's agent, to give exact facsimiles of messages actually transmitted and received between London and Nottingham.

Fig. 1 represents the writing as it appears when executed in ink on the transmitting paper. The ink employed is of the ordinary writing description, with a little gum added, the paper being of the kind employed generally for wrapping up tea in, that is, paper silvered on one side.

Fig. 2 shows the writing as it appears on the receiving paper, the impressions being actually of a dark blue colour.

Fig. 3 shows a received copy of a rough landscape sketch, also transmitted between London and Birmingham.

Notes.

THE ELECTRIC LIGHT.—Those who have occasion to write on the electric light in all its variety, have felt the need of a specific term for the bodies emitting the light. Hitherto they have been called carbons, since carbon rods have been almost always used; but carbon is no longer the only substance employed and it may ultimately be abandoned. A single luminous body is also usurping the place of the voltaic arc; therefore the word *electrodes* frequently applied, but too general in its electrical signification, is unsuitable. *Wick*, a word borrowed by analogy from the candle, is apt enough as a makeshift, but an entirely new word is wanted. The best we have been able thus far to suggest is *Electro-pyre*, from the Greek *pur*, a fire, (hence pyre, or fuel giving out light and heat). The electro-pyre would thus signify the electric wick, brand, or torch, which emits the electric light. The light itself could be appropriately termed *electro-phare* (from *pharos* a beacon), a single word, and more euphonious than electric light, which, however, has already a great hold on usage.

EDISON'S ELECTRIC LIGHT.—Mr. Edison has announced that he has devised a current meter for the electric light, and completed his apparatus for lighting. He is now engaged in determining the cost of his system, and maintains that it will at least be decidedly cheaper than gas. He is having a large new brick workshop and offices erected close by his present laboratory. He is reported by the New York *World* to have said, "I don't know when I am going to stop making improvements in the electric light. I've just got another one that I found out by accident. I was experimenting with one of my burners when I dropped a screw-driver on to it. Instantly the light was almost doubled and continued to burn with increased power. I examined the burner and found it had been knocked out of shape. I restored it to its original form and the light decreased. Now I make all my burners in the form accidentally given to that one by the screw-driver." Mr. Edison added, "that it was almost impossible to calculate with certainty of his light," but that, "he had engaged a mathematician to work out the problem from his data." He also said that the extinction of one light so regulated the current that only enough is supplied to keep the other lamps burning. He admitted that his system would only give say 500 candle power when the carbon lamps would give 1,000; but he claims to so divide up his 500 candle light as to make it more efficient than the 1,000 light. This ratio agrees with the experimental results of Tyndall, who found that an incandescent platinum wire only emitted 1 luminous ray to every 23 dark heat rays, whereas the voltaic arc gave out 1 luminous ray to 9 dark ones. A coal gas flame gives out 1 light ray to 24 dark rays.

AN objection to Edison's English Electric Light Patent was filed at the Patent Office by Messrs. Herbert & Co., agents for Mr. J. H. Russel, on Dec. 3. The ground taken is that Edison is not the first and true inventor.

MR. EDISON authorises the statement that his light is produced by the incandescence of an alloy of platinum and iridium. The conductor is not an ordinary coil, but a peculiar arrangement of the metal, whereby, in accordance with a new discovery of his in connection with radiant energy, a much weaker current is made to generate a given light than if a single spiral were used. By slight modifications in the shape of the conductor he has obtained from one cell of a Daniell battery a light strong enough to read by. A simple adjustable apparatus attached to each lamp regulates the amount of electricity it shall draw from the main current, and makes it entirely independent of any changes in the strength of the current as well as of all other lamps in the circuit. That portion of the current which is used for the regulator is also made to serve in the production of the light. A part of Mr. Edison's device for compensating for loss in subdivision consists apparently in the utilisation for illuminating purposes of the resistance of the regulator, and of all other resistance outside of the main conductor, and part in the peculiar form of the conductor. The details are still a secret.

Mr. Edison has just obtained two patents here, and has applications for nine others, pending specifications for a third English patent just forwarded.—*Daily News* Telegram, New York, Dec. 11th.

THE electric light was recently tried in Bristol Cathedral, and gave great satisfaction. The apparatus consisted of a large voltaic battery and a Foucault lamp. The experiment was made by the Rev. P. Sleeman, F.R.A.S., and is the first instance on record of a cathedral being lit by the new illuminator.

THE run of new electric light patents is beginning to slacken, and specifications for "curative magnetic appliances" and "electric snuff" are again all too conspicuous.

MANY gas companies are determined to attempt to secure Parliamentary powers next Session to enable

them to supply the electric light, as well as to extend the use of gas to cooking and heating. Among these may be mentioned the Preston, Plymouth, Newcastle, Brighton, Bromley, Wisbeach, Lancaster gas companies, and the Alliance Company of Dublin. The corporations of Leeds, Warrington, Blackburn, Birmingham, and other towns, are also resolved to apply for similar powers, which there is little fear of Parliament granting.

THE electric light is likely to be speedily adopted into all the large mills of Sheffield. It is found that there is generally 10 or 12 horse-power unemployed at these works and this can be efficiently utilised in driving the dynamo-electric machines. Messrs. Cammell & Wilson, Dronfield, have successfully applied the light.

MR. RUSTON, of Ruston, Proctor & Co., of the Sheaf Iron Works, Lincoln, whose engines are just now in demand for electric lighting purposes, have received the Cross of the Legion of Honour for his exhibits at the Paris Exhibition.

THE new steel despatch vessel *Iris* is to be fitted experimentally with Rapieff's electric lamps.

GRAMME and SIEMENS' machines are in great demand just now. We give a full account of the latest form of Gramme in this number. Méritens' machine is *said* to be acquiring favour and to yield three times the current that the Gramme does for the same expenditure of power, and that it can keep one Jablochkoff candle going by ¼ of a horse-power. The cost of the Méritens however is about double that of the Gramme.

THE SIEMENS'-ALTENECK MACHINE.—According to experiments made by M. Petrouschewsky, the Siemens'-Alteneck when worked by from 3 to 5 horse-power produces a current capable of decomposing 400 milligrammes of water per minute, and a light varying from 4,800 to 9,600 stearine candles. Owing to the heterogeneity of the carbons, the intensity of the light varies continually, although the strength of the current continues very steady. The minimum intensity of light observed was 1,000 candles and the maximum 14,800.

PROPERTIES OF THE VOLTAIC ARC.—From recent experiments on the nature of the resistance of the voltaic arc, M. Latschinoff corroborates Mr. Edlund in his conclusion that it is an electro-motive force of polarisation which is produced in the arc. With a battery of 40 Bunsen elements giving a current of 95 electro-magnetic units, the polarisation equalled 12 Bunsen's. The introduction of a little metallic potassium or sodium in the arc effected a reduction of 50 per cent. in the polarisation, and increased the length of the arc.

RESISTANCE OF CARBONS.—M. Borgman has found, by means of the Wheatstone Bridge, that elevation of temperature to orange red heat diminishes the resistance of wood charcoal, anthracite, plumbago, coke, and the carbon electrodes of M. Carré. The thermal co-efficients for 1° C. are,

For wood charcoal	0·00370,	between 26° and 260° C.
Donnez anthracite	0·00265,	between 20° and 260° C.
Alibert plumbago	0·00082,	between 25° and 250° C.
Coke	0·00026,	between 26° and 275° C.

Even feeble radiant heat produces a diminution in the resistance of a plate of wood carbon. The resistance of pine, elm, and ebony charcoal, also diminishes notably between 100° C. and 125° C. of temperature, especially in the case of ebony.

IN a recent note we mentioned that M. Rapieff had constructed a lamp with a single thick upper carbon electrode and a pair of thinner lower ones. Although apparently approximating to Werdermann's plan, this arrangement does not really do so, for the arc is still preserved. We observe that this plan is described in M. Rapieff's 1877 patent.

M. RAPIEFF'S SMALL LAMP or electric candle has been exhibited at the *Times* office along with his larger moderator lamps. It consists of two erect pencils of carbon placed side by side, but with no insulating medium between except air. One pencil is vertical and the other is inclined to it at an angle sufficiently small to make the resistance of the voltaic arc increase as the candle burns down by about the same amount as the resistance of the carbons in circuit decreases. Thus the total resistance of the lamp is kept tolerably constant whatever the length of the carbons consumed. When the current is off, the points of the pencils touch, but by means of a small electro-magnet, one pencil is drawn away from the other, and the arc is established on the passage of the current.

PECULIARITY OF THE ELECTRIC ARC.—Mr. Henry Wilde, of Manchester, has observed the following peculiar property of the electric arc between two upright side by side carbon rods or electro-pyres, namely, that wherever the voltaic arc is established between them, it invariably works its way to their points, and remains there, and this whether the points be uppermost or undermost.

THE temporary hitch in the arrangements for the proposed duplicate cable to Australia has, we believe, been overcome.

THE Corporation of Penzance intend to celebrate the centenary of Sir Humphry Davy this month.

NEW ZEALAND TELEGRAPHY.—We have received the 14th Annual Report of the New Zealand Telegraph Department. From this it appears that each of the islands has a system of land lines, extending throughout their lengths and connected by two cables across Cook's Straits. The total cost of the system thus far amounts to £394,414. The revenue for the year ending June 1878 is £93,704 as against £87,599 of expenditure. The total length of the land lines is 3,434 miles. Poles sawn from the heart of the totara tree are found to be very durable.

THE pre-Easter Royal Institution Friday evening lectures are announced. The first is by Dr. Tyndall on the *Electric Light*, Jan. 17. Sir William Thomson will lecture, Feb. 28, on the "Sorting demon of Maxwell," an uncanny title. This sorting demon is, we presume, the small impish gate-keeper, imagined by Clerk-Mawell, who allows certain molecules to pass through a porous septum across which two gases are diffusing into each other, and keeps back others, thus "sorting" the molecules in each compartment.

IT is stated that unless the working cost of the Jablochkoff system in the *Avenue de l'Opera*, Paris, can be reduced, it will be replaced by gas. Werdermann's light is engaging much attention there. The *Temps* office is to be lit with it; and a committee of three, including M. Du Moncel, and M. Jamin, has been appointed by the French Academy to examine it.

AT the *Seance* of the French Academy for Nov. 25, M. Emile Reynier laid claim to priority of invention of Werdermann's system of electric lighting, which he

(M. Reynier) described in a note to the Academy on May 13. Reynier's light is certainly produced by the incandescence of a fine rod of carbon touching a thicker carbon electrode, but not in the same way as Werdermann's.

THE BRITISH ELECTRIC LIGHT COMPANY have issued their price list. Gramme machines, giving lights ranging from 800 to 45,000 standard candles, are quoted at from £70 to £560, the Serrin lamp being taken as the emitter. For these machines the driving power required rises from ½ to 13 horse-power. Serrin lamps, with fixed focus and giving a 4-hour light without change of carbons, are quoted at £17; Jaspar lamps of the same sort £12; Chertemps, with a shifting focus, and 4-hour duration, £8 10s.; Suisse, with shifting focus and 10-hour duration, £13. All other accessories are to be supplied by the Company.

THE INVENTOR OF THE TELEPHONE.—A public banquet has been given in honour of Elisha Gray, at Highland Park, Ill., of which place he is a citizen. It was there claimed for him by a Mr. S. R. Bingham in the second toast on "The Telephone and its Origin," that he was the first and true inventor of the articulating telephone. Mr. Bingham stated that Gray had filed a U.S. patent caveat on Feb. 14th, 1876, for a speaking telephone, and that although Bell took out a telephone patent on the same day, no mention or claim of a speaking telephone was made in it, and that it was only in January, 1877, or nearly a year afterwards, that Bell patented his speaking telephone "containing practically the same patterns and specifications contained in Mr. Gray's caveat." The best answer to such a statement is the simple fact that Bell's articulating telephone was exhibited in action at the Philadelphia Exhibition in June, 1876, before Sir William Thomson, the Emperor of Brazil, and others; and that Sir William in his official report thus alludes to it: "Mr. Alexander Graham Bell exhibits apparatus by which he has achieved a result of transcendant scientific interest —the transmission of spoken words by electric currents through a telegraph wire." Bell exhibited his speaking telephone publicly in America, while Gray had only a musical telephone to show, and, later, Bell succeeded where Gray failed, for he made the electro-magnetic receiver employed by Gray act also as a transmitter. We have no wish to detract from the well-merited tribute paid to Elisha Gray by his fellow-citizens; but assuredly posterity (if not in the United States at least in more important parts of the world) will give an equal, if not a greater share, of the honour of inventing the telephone to Prof. Bell. It is a singular fact that all the enthusiasm and incense of praise called forth by Bell's invention in America when it first appeared, has vanished as if by magic. Unhappily for Prof. Bell he had the misfortune to be an Englishman, and still worse, he committed the sin of owning it. After this rash avowal, the swelling pride of Americans in him collapsed, like superheated steam before a jet of cold water, and a native hero was found out for their worship. This is a possible explanation, but we suspect the true one is opposing company interests. Cromwell Varley has quite as much right to be styled the true inventor of multiple harmonic telegraphy, as Elisha Gray has to be styled the inventor of the speaking telephone.

SELF-INDUCTION TELEPHONES.—It was to be expected that a telephone might be constructed from a fine spiral conductor traversed by a current, and connected to a vibrating diaphragm in such a manner that the vibrations caused the spires of the conductor to approach to and recede from one another. For then the self-induction of the spires would modify the current according to the vibrations. Such a telephone has been made by Mr. G. Johnstone Storey of Dublin, and is described in *Nature* for Nov. 28. Mr. Storey distinctly heard the scraping of a file by a telephone of this kind, no magnets being employed. One end of a spiral of copper wire was fixed, and the other attached to a drum-head. Another arrangement consisted of a similar spiral of iron wire enclosed in a coil traversed by a current.

THE MICROPHONE.—The French Telegraphic Administration are at present trying the articulating powers of Professor Hughes' "hammer and anvil" form of transmitting microphone against the Edison carbon telephone transmitter, with a view to the adoption of the better in connection with an electro-magnetic receiving telephone. Experiments have been successfully carried on with the microphone between Paris and Versailles. It is believed that the microphone will be useful in field telegraphy.

THE FIRST HUGHES' TYPE PRINTER.—*Apropos* of Prof. Hughes portrait biography in our issue for November 15th, we have received an interesting letter from Mr. Louis Schaefer, mechanician to the Eastern Telegraph Company at Malta, who it appears made the first type printer for Prof. Hughes when he went to Louisville for the purpose in 1854. Mr. Schaefer, who had served some years with Siemens & Halske in his native country, was then thrown out of his legitimate employment by the bankruptcy of a firm of opticians in Louisville, and was earning his living by artistic labours, which ranged from ornamental engraving to house painting. "I remember well," he says, "I was passing along Third Street with a good long ladder, and a good sized colour tub and brush, when Mr. Hirschbuhl, a German watchmaker and friend of mine, stopped me, by holding up in his hands the frame of an old American clock, saying at the same time, 'Now there is plenty of work for you; firstly I want you to whitewash my house, and secondly, can you make a telegraph instrument?'" The telegraph instrument in question, was the first Hughes' printer. The first pretty little instrument," says Mr. Schaefer, "only 13 inches square, by 7 inches high, consisting of a clockwork of an arched design, with revolving type- wheel, vibrating regulator, keyboard, and alphabet, was finished by me in three months, and exhibited at a ladies' fair held in Louisville in midsummer, 1855, where it earned the admiration of all beholders."

THE HOSMER MOTOR.—The American newspapers have got hold of another new marvel in the shape of a magnetic motor, invented by Miss Harriett Hosmer, an American artist, residing at Rome. Although no description of it has been published yet, there are already two claimants for priority of invention! The motor is said to run through the agency of a permanent magnet, and were it not for the fact that layers of different substances are spoken of in a way suggestive of galvanism, we should judge that the "perpetual motion" dream had turned up again. Miss Hosmer's claim is that by means of a permanent magnet any amount of power can be secured at a trifling cost; and another statement is to the effect that the motor draws its power from "that great magnet called the earth." A means of employing the earth's magnetism for motive purposes, like wind or sunlight, though visionary, is perhaps not absolutely impracticable. We are told that Miss Hosmer's motor is now being constructed in London; but if so the work must be done with more than Edisonian secrecy.

THE JERSEY CABLE.—The fault in the Jersey Cable was localised on the 6th inst., and found to be distant about 300 yards from the Dartmouth ends. The fault was a nearly complete disconnection, the cable not giving earth. This is an unusual kind of fault to occur in a gutta-percha core, though a frequent one in india-rubber cables. It is anticipated that the cable will very shortly be through again to Jersey.

A SHORT cable from Darien to Doboy Island, the port for Darien, has been laid and opened for business.

A WEDDING was recently consummated by telegraph between a bride in Ohio and a bridegroom in Colorado. The lady took the next train for Colorado.

DR. MUIRHEAD, who has been delayed in his work by repeated toredo interruptions on the cable, succeeded in completing the duplexing of the Madras to Penang cable in a few hours after it was placed at his disposal. He will return home early in January.

THE yellow fever pestilence in the Southern United States is fast abating. The mortality amongst telegraph operators has been so great that some people attribute it to a mysterious effect of electricity.

WE learn from the *Journal of the Telegraph* that a project is on foot to connect Cape San Antonio, Cuba, with Guatemala by submarine telegraph, and that concessions have already been obtained in Honduras and Salvador.

THE same journal announces that several new features have been added to the American District Telegraph. One of them is an arrangement with the leading theatres, by which subscribers may obtain seats for the performances without the trouble of going to the box-offices. Another is a simple and much needed system of avoiding the delays and obstacles incident to checking baggage. Another is a training school for the hundreds of boys employed by the company. In the theatre system every theatre reserves a choice row of "American District Seats" for the service of the company's subscribers. In the baggage checking system the messenger summoned by the district wire sees to the checking of luggage to any address, proper arrangements having been entered into with the railway companies. Another improvement is the establishment of a "Bureau of General Information." It appears that four-fifths of the Stock prices of Wall Street is delivered by district messenger boys, and errors have arisen from boys delivering at the wrong brokers. These errors are now obviated by the bureau referred to, which consists of thoroughly posted messengers stationed in different places. If a boy mistake a number he now seeks one of these bureau messengers and asks information. By this means delays of more than a minute are rendered impossible. The "signal" is another development of the service. It consists of automatic or other alarms placed in warehouses and other buildings and in connection with the District office. Watchmen on duty are required to notify their presence by timely signals; should these fail, another watchman is despatched to see what is the matter. Automatic burglar and fire-alarms are also worked in connection with the District offices.

CANADIAN TELEGRAPHY.—A correspondent of the American *Operator* has drawn attention to the telegraphic prosperity of Canada. In the Dominion there are 30,000 miles of wire, and 1,400 offices to 4,000,000 of people, or one mile of wire to every 133 persons, and one office to every 2,857 persons. In the United States there are 267,000 miles of wire, and 7,500 offices to 40,000,000 of people, or one mile of wire to every 150 persons, and one office to every 5,333 persons. In England there are 113,000 miles of wire, and 5,375 offices to 32,000,000 of people, or one mile of wire to every 283 persons, and one office to every 5,950 persons. A twenty word message can now be sent over the entire system of the Montreal Telegraph Company (which extend from Sackville, New Brunswick, on the east, to Sandwich on the west—a distance of 1,200 miles) for 25 cents. (1s.), with a charge of a cent. for each additional word. In Canada, also, local messages sent between places 12 miles and less apart, cost only 15 cents. The Canadian tariff is thus the cheapest in the world.

A TELEGRAPH line is to be erected between Tientsin and Takee by the Chinese students in Tientsin college.

WE have received from a subscriber in the Santa Clara College, California, a descriptive calendar of that important educational establishment. It has developed out of the old Indian mission founded by Franciscan brethren in 1777, and is now conducted by a band of Jesuit fathers. A complete classical, commercial, and scientific education can be obtained there. The college including in itself, laboratories, theatres, debating halls, printing rooms, &c., &c. American professors are famous for the variety of their themes, and we observe that the secretary of Santa Clara, the Rev. E. M. Natini, S.J., is at the same time professor of poetry, telegraphy, shorthand, and French.

AN ELECTRICAL SEISMOGRAPH.—An important exhibit in the Paris Exhibition was an electrically registering Seismograph constructed by M. Breguet, for measuring the deviations of a long pendulum under the influence of terrestrial movements or solar-lunar attractions. It consisted of a heavy pendulum suspended by a wire from a support above, and carrying a pointer below which traversed in close proximity to a horizontal sheet of white paper travelling over a flat metallic plate, by the rotation of a pair of rollers in gear with the train of a clock. The pendulum and metallic plate were insulated from one another and were respectively connected to the two terminals of a small induction coil, which was by a movement in the clock periodically placed in circuit for a few seconds with a battery. Whenever this took place sparks passed through the paper between the pointer of the pendulum and metallic plate, causing a series of perforations to be produced on the paper band, which could thus be used as a record or as a stencil plate for making reproductions by a similar process to that employed in connection with the electric pen of Mr. Edison.—*Engineering*.

A HIGH RESISTANCE RHEOSTAT.—Dr. Oehme, an American, has designed an adjustable resistance of powdered plumbago or stove blacking, by inlaying a thick line of the latter on an insulating base, and covering it with a second insulating cover pierced with plug holes at different distances corresponding to the resistances required. Two plugs serve for electrodes, and the resistance of the line of carbon inserted in circuit is determined by the position of the plugs.

MAGNETISATION OF STEEL TUBES.—According to further researches of M. J. M. Gaugain, when a system of steel jars formed of two parts endowed with different degrees of coercitive force is subjected to the magnetising action of a feeble electric current, the part which possesses the least coercitive force is always that which takes the strongest magnetisation, whether it take the form of a core or a tube. This result is analogous to those formerly obtained with plain bars, annealed or tempered.

Electric Spark in Gases.—According to M. Villari, an Italian Physicist, the heat generated by the electric discharge from Leyden jars in different gases is nearly in strict proportion to the quantity of electricity in the jars. The ratio holds, although the form, material, and distance apart of the electrodes is varied.

Dilatation of Bodies by Electrification.—At a recent meeting of the French Academy of Sciences, M. E. Duter described some experiments tending to show that in certain cases electrification changed the volume of bodies. A large thermometer tube is filled with water and coated outside with tinfoil. The tube then forms a Leyden jar or condenser, the water being the interior conductor, the foil the exterior conductor, and the glass tube the insulator. A platinum wire inserted into the water inside acts as an electrode or charging rod. As soon as the jar is electrified the water is seen to sink to a lower level, at which it remains until the jar is discharged, when it immediately regains its former height. Since, in a condenser electricity only resides in the insulator, it is natural to conclude from this experiment that the glass itself is dilated, and this inference is supported by the fact that whatever be the nature of the armatures, tinfoil, water, saline, or mercury solutions, the same apparent contraction of the internal liquid is observed. In order to remove all doubts M. Duter modified the apparatus by placing the Leyden jar in an envelope of closed glass, terminated also by a thermometric stem and filled equally with a liquid conductor. In this arrangement the liquid of the internal reservoir formed the interior armature of the condenser, and the liquid of the envelope formed the exterior armature, the glass tube forming, as before, the insulator. This glass tube ought, if the inference be correct, to enlarge itself by electrification. The result was that while the inner liquid sank the outer liquid rose to an equal amount, thus proving the accuracy of the inference. As soon as the apparatus was discharged, the original levels were restored. The conclusion is that the internal capacity of a Leyden jar and the external volume are increased by charging it with static electricity. Temperature cannot cause this change since the effect is immediate on charging and discharging. Electric pressure cannot cause it, because it would be the same on both sides of the dielectric, and a diminution of volume would be the result. It is not due to the polarity of the armatures, for on reversing the poles the effect is the same.

M. Jamin pointed out that the first observation of M. Duter, namely, that the internal volume of a Leyden jar is increased by charging it, was noticed by M. Govi about ten years ago, in the transactions of the Academy of Turin; but that he had not seen as M. Duter had done, that the exterior volume also increased.

Platinum Plating.—Prof. Boettger recommends the following bath for plating divers metals with platinum. Freshly precipitated ammonium-platinum-chloride is treated at the boiling point with a concentrated aqueous solution of citrate of soda. The result is an orange coloured solution, of slightly acid reaction, and rich in platinum. The decomposition of this bath, by the current from two or three Bunsen cells, produces a uniform and lustrous layer of platinum.

The Telephone Company.—Mr. W. H. Morris, Secretary to the Bell Telephone Company, states that telephones are now supplied at a yearly rental of from 10s. 6d. to £5 5s., acccording to distance and class of instrument required.

The Invention of Gutta-Percha Core.—A decision was rendered on November 26th by Judge Blatchford in the U.S. Circuit Court, New York, in the suit of Clinton G. Colgate *v.* the Western Union Telegraph Company. The case has been pending over six years, and was founded on a patent granted to G. B. Simpson, May 21, 1867 for the insulation of submarine wires by gutta-percha applied by means of a solvent or by heat, Mr. Simpson claiming to be the inventor of this mode of insulating telegraph wires. The insulating properties of gutta-percha were first announced by Faraday on March 1, 1848; but it is shown that Simpson had, prior to that time, made a like discovery, having patented the application of gutta-percha as an insulator in January and February 1848. The W. U. Company maintained that the subject of the 1867 patent was not patentable matter, and that it was before known and used. The Judge ruled in favour of the plaintiff granting an injunction and an account with costs. The W. U. Company intend to appeal against this decision. They have 60,000 miles of wire in use insulated by gutta-percha (?). Unless the Company obtains a suspension of the injunction, under probable heavy bonds, its business will be seriously interfered with.

Reviews.

The Trans-Atlantic Submarine Telegraph. A brief narrative of the principal incidents in the history of the Atlantic Telegraph Company, compiled from authentic and original documents by the late George Saward, Secretary to the Company. Printed for private circulation.

This little book, a posthumous work of George Saward, published by his widow, is one of the most interesting and readable contributions to the history of telegraphy which it has been our lot to read. Mr. Saward's name was once a familiar one in the telegraphic world, and this modest but excellent memorial of him will serve to revive it amongst his old contemporaries as well as to bring it to the notice of a later generation.

A Handbook of the Electro-Magnetic Telegraph. By A. E. Loring. New York: D. Van Nostrand. Price 50 cents.

This tiny treatise, 6 by 4 inches in area, is a telegraphist's primer by an American practical telegraph*er*, as our cousins with a go-ahead indifference to etymology prefer to say, and is designed to serve as a stepping-stone to larger works of the telegraphist be he so minded. It begins with first principles and rises to testing and construction of lines, fitting of offices, &c., and we should say that it would be a welcome little book to American operators. English operators have no such manual; they may not require it; but to those who feel the need we can recommend this cheap publication, and we can fancy some eager young telegraphist devouring it greedily. On page 64 is a description of a gravity Daniell battery termed the "Hill" battery, which is an old battery of Sir William Thomson's in a new guise. This American transplantation can be explained, for, if we mistake not, Mr. Hill was one of Sir William's students eight years ago.

The Art of Scientific Discovery, or the General Conditions and Methods of Research in Physics and Chemistry. By G. GORE, LL.D., F.R.S. Longmans, Green, & Co.

THE object of this work is to elucidate the nature of scientific research, the personal qualifications required for its successful pursuit, and the general methods by which it is conducted. It must prove a "guide, philosopher, and friend" to young scientific aspirants of all kinds, and it should form a part of every scientific library. The weakest parts of the book are the prosy mottoes prefixed to the chapters. The author is evidently under the conviction that they are poetry, for he has printed them in verse. When will men of science cease to attempt the poetical?

New Patents.

4696. "Electric telegraph insulators." C. E. CRIGHTON. Dated Nov. 19.

4762. "Improvements in machines and appliances for generating electric currents and in apparatus for measuring electric currents." J. T. SPRAGUE. Dated Nov. 22.

4812. "Machinery for generating electricity." F. W. C. VOGEL (communicated by N. C. Vogel). Dated Nov. 26.

4844. "An improved dynamo-electric machine for producing electric currents." J. L. PULVERMACHER. Dated Nov. 28.

4847. "Improvements in and relating to electric lamps, and to a method of charging such lamps with an artificial atmosphere and purifying the same; and to the production of a carbon for use in electric lamps and for other electric purposes." F. J. CHEESEBROUGH (communicated by W. E. Sawyer and A. Man). Dated Nov. 28.

4873. "Improvements in electric telegraphs and in apparatus connected therewith." Sir C. T. BRIGHT. Dated Nov. 29.

4903. "Magnetic apparatus to be employed for curative and remedial purposes." R. LONSDALE. Dated Dec. 2.

4921. "Improvements in and relating to the electro-deposition of nickel and in articles manufactured of or plated with the same, which invention is partly applicable to the electro-deposition of other metals." W. R. LAKE (communicated by E. Weston). Dated Dec. 2.

4961. "Magnetic appliances for curative purposes." H. C. BYSHE. Dated Dec. 4.

4924. "A medical preparation applicable to the treatment of tic-doloreux and toothache called Handysides' electric nervine snuff." W. HANDYSIDES. Dated Dec. 3.

4960. "Apparatus for generating electric currents and for producing electric light." A. V. NEWTON (communicated by the Weston Dynamo-electric Machine Co.). Dated Dec. 4.

4988. "Improvements in or appertaining to apparatus for producing or concentrating electricity and in the production of electric light or compound electric and combustion lights." S. P. THOMPSON and W. P. THOMPSON. Dated Dec. 5.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

844. "Apparatus for conveying sound." E. COXWALKER. Dated March 2, 1878. 2d. This consists in applying mouthpieces and tubes to telephones or sound producing bodies. *Not proceeded with.*

861. "Apparatus for producing electric light." T. F. SCOTT. Dated March 2, 1878. 2d. This consists in forming carbons for the electric light by moulding a paste of carbon and flour or starch; also in making ribbons of carbon and asbestos or other fibres, which ribbons are slowly revolved on rollers opposite each other, the arc being formed between them; also in diminishing the waste of the carbons yielding the light by delivering a stream of finely powdered carbon on the ignited points, and thereby diminishing the waste of the latter; hollow carbon electrodes mounted on axes slightly inclined to one another are also employed to yield the arc.

915. "Transmitting power by electric currents." H. C. SPALDING, Bloomfield, N.J., United States. Dated March 6, 1878. 6d. This consists of an electro-motor formed of an electro-magnetic armature rotating in a soft iron shell, having projecting teeth at intervals interiorly, which exert a forward pull on the armature when the current in the latter renders it magnetic.

920. "Electric lamp apparatus." PIERRE DRONIER. Dated March 7, 1878. 2d. This consists in a means of lighting a spirit lamp by the electric incandescence of a fine platinum spiral. *Not proceeded with.*

Proceedings of Societies.

THE ELECTRIC LIGHT AT THE SOCIETY OF ARTS.

AT the general meeting of this society, held on Wednesday, December 4th, Dr. C. W. Siemens in the chair, the Paper was read by Mr. J. N. Shoolbred, B.A., M.I.C.E., the subject being "The Practical Application of Electricity to Lighting Purposes." The lecture hall was crowded to excess, a very large number of visitors being unable to obtain admission.

The lecture hall was principally lighted by means of a Siemens' electric lamp placed at the centre of the ceiling, the electric current being produced by a dynamo-machine, also of Siemens' construction and form. Other lamps by Suisse and Halle, were employed to light up the entrance halls and passages, the current being generated by a Gramme machine, driven by a 2½ horse-power Otto gas engine. Specimens of the Rapieff, Wallace-Farmer, &c., lamps were also exhibited, though not lighted. Numerous diagrams of the varieties of lamps and dynamo-machines were placed on the walls and admirably illustrated the lecture. A diagram of Messrs. Thomson, Sterne and Co.'s engine, which is worked by the explosion of purely divided hydrocarbons, such as pretroleum, mixed with air, was also given.

MR. SHOOLBRED, at the commencement of his discourse, said that the object of his paper was to bring before his audience the results of a few of the applications of the electric light to illuminating purposes. With regard to the employment of the electric light for lighthouses, this could not be taken as a basis of the economical view of the question. In lighthouses the question was not primarily one of expense, but

simply that of attaining the most brilliant light possible consistent with reliability, and these requirements the electric light afforded.

At the La Chapelle Goods Station belonging to the Northern Railway Company of France, the electric light was introduced, since it was found that with the ordinary means of illumination, the work could not be carried on so satisfactorily by night as by day, and, moreover, a large number of small articles were overlooked and lost. The introduction of the light proved a complete success, both as regards efficiency and economy, a saving of 60 per cent. in favour of the electric light over the gas being effected by the use of the former. The apparatus used for the purpose consisted of a Gramme machine and a Suisse lamp.

At Rouen, Messrs. Powell introduced the light into their works at a cost of £196; a small size Gramme machine and two Serrin lamps being employed, an indicated engine power equal to 2½ horses being consumed in driving the machine. The light, which was equivalent to nearly 2,000 candles, was produced at an estimated cost of 2s. 10d. per hour, as against 7s. 7d. for an equally effective illumination by gas, the price of the latter being 7s. 8d. per 1,000 cubic feet.

At the Paris terminus of the Paris, Lyons, and Mediterranean Railway Company, the Lontin electric light system was tried; 28 Serrin lamps (each equal to 80 gas jets) being fixed in the place of 172 gas jets. The result was so satisfactory after nearly two months' trial that the company determined to apply the system to one of their goods sheds, employing 12 Serrin lamps; the total cost of the system being 5s. per hour.

At the St. Lazare Station of the Western Railway Company of France, the electric light has been adopted, a Lontin double machine being employed with six Serrin lamps; the total cost per hour being about 4s. The light has also been adopted at the Salle des Pas Perdus Station of the same company.

With regard to the Jablochkoff light, Mr. Shoolbred said that no reliable details could be obtained as to the cost of the system, but as far as could be seen it exceeded the cost of gas 2·6 times, although the Société Generalé de l'Electricité have since offered to work the light at the rate of the price originally paid for the gas. Mr. Shoolbred, however, contended that the Jablochkoff system was after all, in its present form, but a rude device.

The Rapieff light, Mr. Shoolbred remarked, seemed satisfactory, although the trials made of it up to the present time did not warrant any definite opinion being given as to its efficiency, &c.

In the discussion which followed, Mr. Douglas, Engineer to the Trinity Board, stated that the electric light at the Souter Pont had only failed twice during a period of eight years—once from the attendant falling asleep, and once from a failure in one of the carbon points.

Mr. Preece stated that his opinion of the electric light was that each form of lamp possessed some particular good feature, but none possessed them all.

As to the Edison light, he expressed his opinion that it was a mare's nest.

The electric light considered generally, he thought, was the light of the future, as regarded the illumination of large open spaces.

SOCIETY OF TELEGRAPH ENGINEERS.

At the ordinary general meeting of this society, held at Great George Street on the 27th ult., Dr. C. W. Siemens, F.R.S., in the chair, a Paper was read by Major Webber, R.E., on "Multiplex Telegraphy at the Paris Exhibition, and the Harmonic Telegraph of Elisha Gray."

The principle of the multiplex telegraph system, invented by Meyer, and modified and improved by Baudot, an employé in the service of the French Telegraph Administration, is that of utilising all the currents which can be made to succeed one another in a given time on a telegraph wire, so that several operators can transmit on the same wire. The sending apparatus consists of a set of transmitting keys and a receiver for each operator, and of a distributor which puts the working battery in connection with each of the receivers in succession, and also connects the latter to line. At the receiving end a somewhat similar distributor, working synchronously with that at the transmitting end, puts the receiving printing instruments successively in connection with the line wire. The exact construction of the apparatus, and of the modification and improvements introduced by M. Baudot, cannot be explained without elaborate diagrams, and therefore it will not be attempted here. The harmonic telegraph of Mr. Elisha Gray of Chicago, was exhibited working at the meeting. The principle of the apparatus lies in the fact that a vibrating rod tuned to give out a certain note, and caused to vibrate by the action of an electro-magnet, will not respond if a greater or less number of electric impulses be caused to pass through the electro-magnet, than is equivalent to the rate of vibration of the note to which the rod is tuned, and that if several such vibration rods and magnets be vibrated in one circuit, they will each or all respond to vibrating impulses sent through them, each one pointing out the particular vibrations to which it can respond; and as these impulses, if sent by different keys at the same time will be transmitted as composite tones, the vibrating rods, whose rates of vibration correspond to the currents sent by the different keys, will each respond in unison to the particular key to which it corresponds. The operator can either read by the sound given out by his particular vibrator, or the latter, when in a continual state of vibration, can be caused to actuate a relay.

In the course of his paper, Major Webber referred to the encouragement and assistance given to M. Baudot by the French authorities, stating that every facility, both as regards mechanical and pecuniary aid, was given to enable the improvements to be carried out.

The meeting terminated by the usual vote of thanks, the discussion on the paper being postponed till the next meeting.

General Science Columns.

Parasitic Life on Submarine Cables. — The amount of submarine life that comes up on a cable which is taken up for repairs after being immersed for a year or two is surprising. Three years ago the writer was with a repairing expedition on the Para to Cayenne section of the Western and Brazilian Company's cables We were chiefly at work off the Island of Marajo, in the estuary of the Amazon. The cable had only been submerged about a month; yet it came on board the ship at places literally covered with barnacles; at others overgrown with submarine vegetation, crabs, and curious shells, often of singular delicacy and beauty. The sea-weeds were in great variety clinging to the cable, sometimes in thick groves of red and yellow algæ; slender, transparent, feathery grasses; red slimy fucoids, and tufts of amethyst moss. We found branching coralline plants upwards of a foot in height growing to the cable, the soft skeleton being covered

with a fleshy skin, generally of a deep orange colour. Sometimes a sponge was found attached to the roots of the corals, and delicate calcareous structures of varied tints incrusted the stems of all these plants and served to ornament as well as to strengthen them. Parasitic life seems to be as rife under these soft tepid waters as it is on the neighbouring tropical shores. Many star-fishes, zoophytes, and curious crabs and crustaceans were likewise fished up on the cable. The crabs were often themselves completely overgrown with the indigenous vegetation of the bottom, and so were scarcely distinguishable from it. Others, although not so covered, were found to have the same tints as the vegetation they inhabited, and even in structure somewhat resembled the latter. Others again were perfectly or partially transparent; and one most beautiful hyaline crab, new to science, united in its person several of the prevailing colours of the bottom. Its slender limbs, like jointed filaments of glass, were stained here and there of a deep topaz brown. Its snout, pointed like a needle, was of a deep scarlet; its triangular body was orange yellow; its eyes were green, and its tiny hands of an amethyst blue.—J. Munro in *Chamber's Journal.*

Phosphorescent Dials.—Some time ago it was reported that watches were being made in Switzerland with phosphorescent dials, so that the hour could be ascertained from them at any time of night without the aid of artificial light. Recently an Eastern clock company has been manufacturing clocks with this same kind of self-illuminating faces, and they have been on exhibition in the windows of several of our city stores. M. Olivier Mathey, a Neufchâtel chemist, communicates the following information in regard to the composition of these dials to one of our French exchanges: Phosphorescent dials are usually made of paper or thin cardboard, enamelled like visiting cards; they are covered with an adhesive varnish, or with white wax mixed with a little turpentine, upon which is dusted, with a fine sieve, powdered sulphide of barium—a salt which retains its phosphorescence for some little time. The sulphides of strontium and calcium possess the same property, but lose it more quickly than the former. After the dial has remained in darkness some days it loses its phosphorescence; but this may be readily restored by exposure of an hour to sunlight, or better still, by burning near the dial a few inches of magnesium wire, which gives forth numerous chemical rays.—*Scientific American.*

Influence of the Sun on Trade.—Prof. Stanley Jevons in *Nature* of Nov. 14, seriously advocates the establishment of solar observatories on elevated tableland in different parts of the world, so that the heating power of the sun should be daily measured. This suggestion is forced upon him by an investigation into the commercial crises of the past, from which it appears that these "credit cycles" are decennial and coincident with the cycle of the sun's spots.

Sir William Thomson suggests the application of his system of flashing lights to the river Thames. By it, each beacon flashes a distinctive letter in the Morse code by means of a periodic eclipsing apparatus, the best being Evans' electro-magnetic eclipser.

Meteoric Gold.—The *Yuma Sentinel* of California states that there was recently found in the Mohave Desert a curious meteorite of a steel gray, tinged with yellow, and having a crystalline fracture. It has some free gold on its surface, and resists the action of various acid baths, as well as cold chisels. It is not magnetic.

Petri's Speed Indicator (constructed by Messrs. Siemens Bros.), is designed to fill a want felt in working busy railways. It indicates the speed of a train, locomotive, or other machine, on a dial in view of the driver, and gives also a graphical record of the times of the journey and stoppages, as well as of the actual speed. The safety of railway working is much increased by a proper speed indicator, and the expenses decreased; while in accidents clear proof is obtained of the speed at which the trains were running at the time. The speed during an interval of 15 seconds, or longer if convenient, is shown by the position of an index hand on a dial, the hand resting there during an equal interval of time. This speed is also recorded by a hammer striking a pricking point connected to the index, so as to make it pierce a moving strip of paper. After having remained at rest for 15 seconds, the index again moves to a position indicating the speed for the succeeding interval, and there rests for 15 seconds, the pricking being done as before. In this way the contrivance works. The maximum speed during the period of working is recorded by a second index, which remains locked at that position on the dial. An alarm bell can also be rung when a certain predetermined speed of working has been attained

The seaside village of Westgate-on-Sea, Thanet, has been lit up by electric light; and the inhabitants are priding themselves on thus being in the very van of progress.

The Holborn Viaduct is shortly to be lit by Jablochkoff's electric candle.

Werdermann's system will be tried in front of the Mansion House.

At a recent meeting of the City Commission of Sewers, London, the terms quoted by the Gas Light and Coke Company for street lighting during next year were the same as heretofore, namely 18s. per ordinary square lamp, and 20s. per circular lamp, including lighting, cleaning, and repairing. A deputy suggested that in view of the progress of the electric light a reduction ought to be made on these terms, and the question was referred to the Streets Committee.

It being decided to light the streets of the beautiful city of Rio Janeiro by electricity, the Brazilian minister has invited tenders from American firms.

Technological Museum for Sydney, New South Wales.—We are informed that the Government of New South Wales has requested Mr. William Forster, Agent-General for the Colony, Professor Liversidge of the University of Sydney and Mr. E. Combes, M.P., C.M.G., to collect information in the United Kingdom and on the Continent relative to the working of English and foreign Technological Museums and Colleges, with a view to forming similar institutions in Sydney. A sum of money has been placed on the estimates by the Government of the Colony, to enable the committee to purchase suitable specimens.

We have no doubt that the Agent-General for New South Wales (3, Westminster Chambers, S.W.), will be extremely glad to receive from such institutions, or from any other source, reports or any information which would assist the committee in its inquiries.

Electrolytic Reduction of Mercury.—According to F. W. Clarke in the *Berichte der D. C. G.*, if a solution

of mercuric chloride slightly acidulated with sulphuric acid is put in a platinum capsule connected with the zinc pole of a Bunsen bichromate battery of six elements, and the carbon pole connected to a platinum foil electrode dipped into the solution, at first mercurous chloride will be deposited, which will gradually take the metallic state, and at the end of an hour there will be only pure mercury covered with a solution which will not be rendered turbid by ammonia. This liquid is to be drawn off, and the mercury washed with water.

COMMERCIAL NICKEL, according to the *Metall Arbeiter*, contains sometimes 8 per cent of cobalt, and 12 of copper, besides a little iron, arsenic, zinc, manganese, sulphur, carbon, silica, and alumina.

IRIDESCENT GLASS.—Glass is made iridescent by exposing it at a high temperature to the fumes of stannic chloride, to which barium or strontium-nitrate is added, when deep colours are required.

City Notes.

Old Broad Street, December 11th, 1878.

AN Extraordinary General Meeting of the Eastern Extension Australasia and China Telegraph Company, adjourned from the 6th of November, was held on the 4th inst. at the City Terminus Hotel, for the purpose of "approving an agreement with the Governments of the Australian colonies, or some of them, for the duplication of the Australian cable, and preparing resolutions authorising the directors to execute all contracts, and to do all acts requisite for carrying the agreement into effect with such modifications, if any, as the directors may determine, and further authorising the directors to raise the capital required for this purpose, and for the general purposes of the company by the issue of debentures or otherwise upon such terms and in such manner as the directors may determine." Mr. J. Pender, M.P., who presided, in opening the proceedings, said that since the last meeting a good deal of telegraphy had been going on, and he was happy now to be in a position to announce that a telegram had just been received stating that the agreement with the Australian Colonies had been signed, and that the whole matter was now complete, subject to its perfection in this country. The solicitor having at length read the heads of the agreement, the chairman said that its advantages were very great to this company. The Australian Government, when they first laid their line, were not disposed to subsidise in any way, but they had now found out the advantages of telegraphic communication with this country, and owing to a failure in the single cable it had become necessary to duplicate, not because the present cable was insufficient for the work, as it could do ten times as much as it at present did, but for the purpose of avoiding failure of communication in the future. The Australian Government had determined to subsidise the company to the extent of £32,400 a year, for the purpose of securing the additional cable. The arrangement, he urged, was to the advantage of the company, as it would secure a long and successful connection with Australia, without undue competition. They had lost much in the past by interruption. During the last year such loss had amounted to £32,000, and with a duplicated cable such a loss would not occur in future. He thought also that they would be able to afford to the public a more reliable and efficient communication. The reduction they thought of giving to the Press would recoup the company in a short space of time. A large percentage of the traffic passing over their system was transmitted by code, but the bargain for the quarter rate was that all messages should be open. It was proposed to take authority to raise £660,000 to provide the duplicated cable, and to restore the working capital expended on the ships *Sherard Osborne* and *Agnes*. It was proposed to redeem the capital by annual drawings, the funds for which purpose would be derived from increased profits, and the saving resulting from the non-interruption of the traffic. In conclusion, he moved "that the agreement now read be, and the same is hereby approved and confirmed, and the directors are authorised to execute all contracts, and do all acts requisite for carrying such agreement into effect, with such modifications, if any, as the directors may determine." —The motion was seconded by Mr. William Massey, and after a brief discussion was carried unanimously.—The chairman next moved, "That the directors be authorised to raise capital for the purposes aforesaid, and for the general purposes of the company, by the issue of debentures not exceeding £660,000 nominal, bearing such rate of interest, and with such special or other security at such price payable or redeemable in such mode, and at such time, and generally upon such terms and in such manner as the directors in their discretion may determine."—The motion having been seconded, the chairman, in reply to a shareholder, said that with such security as they were able to offer they ought to get the money at five per cent. It was proposed to repay the capital thus raised by drawings within 20 years, the period at which the subsidy expired. For this purpose it would be necessary to set aside £20,600 annually; but from the saving effected and the increased traffic they would be able to carry out the work without any sacrifice on the part of the shareholders.—The resolution was unanimously adopted, and the proceedings terminated.

The directors of the Brazilian Submarine Telegraph Company (Limited), have declared an interim dividend of 2s. 6d. per share, or 5 per cent. per annum, free of income tax, for the quarter ended 30th September last, and payable on Tuesday, 24th inst.

On the 7th inst., the Great Northern Telegraph Company notified an interruption of cable communication between Nagasaki and Shanghai, which, however, was restored by the 9th inst., messages being again received for all stations in China as well as Japan.

The following are the late quotations of telegraphs:— Anglo-American, Limited, $57\frac{3}{4}$-$58\frac{1}{4}$; Ditto, Preferred, 85-86; Ditto, Deferred, $32\frac{1}{2}$-$33\frac{1}{2}$; Black Sea, Limited, —; Brazilian Submarine, Limited, $6\frac{1}{2}$-$6\frac{3}{4}$; Cuba, Limited, $8\frac{1}{4}$-$8\frac{3}{4}$; Cuba, Limited, 10 per cent. Preference, $15\frac{1}{4}$-$15\frac{3}{4}$; Direct Spanish, Limited, 2-$2\frac{1}{2}$; Direct Spanish, 10 per cent. Preference, $9\frac{3}{4}$-$10\frac{1}{4}$; Direct United States Cable, Limited, 1877, $11\frac{3}{4}$-12; Eastern, Limited, $7\frac{1}{4}$-$7\frac{1}{2}$; Eastern, 6 per cent. Debentures repayable October, 1883, 102-105; Eastern 5 per cent. Debentures repayable August, 1887, 100-102; Eastern, 6 per cent. Preference, $10\frac{1}{2}$-$10\frac{3}{4}$; Eastern Extension, Australasian and China Limited, $6\frac{7}{8}$-$7\frac{1}{8}$; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 104-107; German Union Telegraph and Trust, 8-$8\frac{1}{2}$; Globe Telegraph and Trust, Limited, $4\frac{7}{8}$-$5\frac{1}{8}$; Globe, 6 per cent. Preference, $10\frac{1}{4}$-$10\frac{1}{2}$; Great Northern, $7\frac{3}{4}$-8; Indo-European, Limited, $19\frac{1}{2}$-$20\frac{1}{2}$; Mediterranean Extension, Limited, $2\frac{3}{4}$-3; Mediterranean Extension, 8 per cent. Preference, $8\frac{3}{4}$-$9\frac{1}{4}$; Reuter's, Limited, 10-11; Submarine, 215-220; Submarine Scrip, $1\frac{3}{4}$-2; West India and Panama, Limited, $1\frac{7}{8}$-$2\frac{1}{8}$; Ditto, 6 per cent. First Preference, $7\frac{3}{4}$-$8\frac{1}{4}$; Ditto, ditto, Second Preference, $7\frac{1}{2}$-8; Western and Brazilian, Limited, $2\frac{1}{4}$-$2\frac{3}{4}$; Ditto, 6 per cent. Debentures "A," 87-92, Ditto, ditto, ditto, "B," 84-88; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds; 114-118; Ditto, 6 per cent. Sterling Bonds, 100-102; Telegraph Construction and Maintenance, Limited, 29-30; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, $2\frac{3}{8}$-$2\frac{5}{8}$; India Rubber Co., 29-30.

INDEX.

ELECTRICAL AND TELEGRAPHIC.

GENERAL SCIENCE.

END OF VOLUME VI.

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